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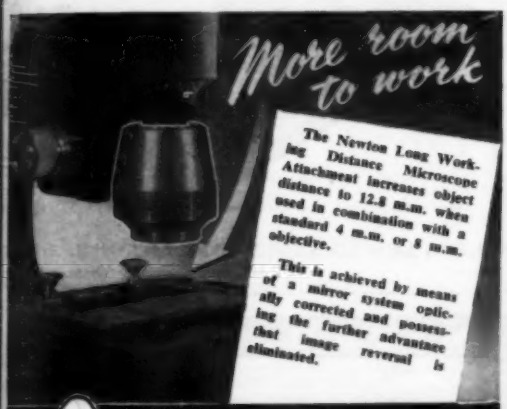

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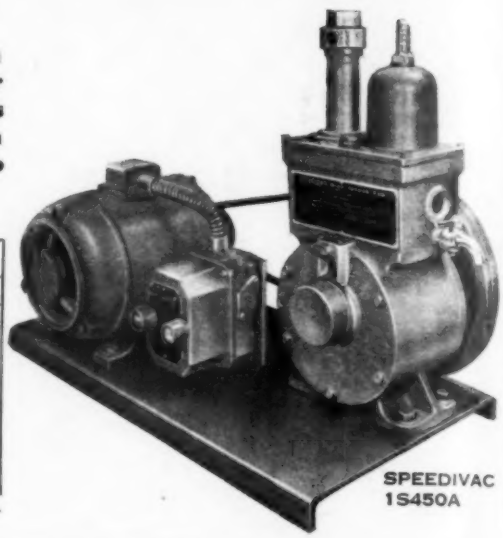

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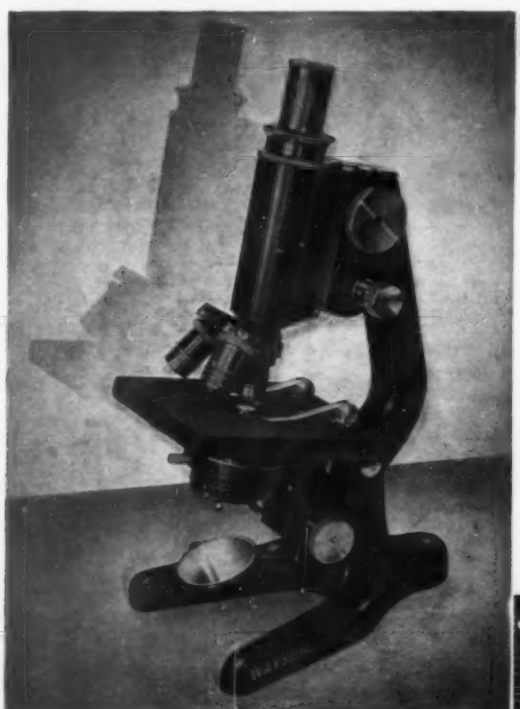

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THE NATIONAL OCEANOGRAPHIC COUNCIL

THE first meeting of the National Oceanographic Council, recently incorporated by Royal Charter, was held on February 7, under the chairmanship of the Civil Lord of the Admiralty, Mr. W. J. Edwards, M.P. The Council consists of thirty-two members representative of Government departments, the learned societies, the universities and other organizations interested in oceanography and its applications. Among the members are representatives of the Governments of Australia, New Zealand and Ceylon, which are giving generous financial support. An executive committee consisting of twelve members under the chairmanship of Mr. W. R. J. Cook, chief of the Royal Naval Scientific Service, was appointed to carry out the general administration and management of the affairs of the Council. The work of the Council will be done mainly in the National Institute of Oceanography, which was founded in 1949 to take over the work of the Discovery Investigations and the oceanographical research group of the Royal Naval Scientific Service. The Council approved the appointments of Dr. G. E. R. Deacon and Captain (S) R. H. G. Franklin as director and secretary of the Institute, and the first annual report was received*.

The National Institute of Oceanography will be concerned with problems bearing on navigation and the natural resources of the oceans, including whales; but most of its effort will be directed towards basic studies of the natural processes which determine the distribution and variations in physical properties, water-movements, and plant and animal populations in the oceans. Two-thirds of the staff will deal primarily with marine physical problems.

It is difficult to urge the importance of a new venture without appearing to undervalue what is being done already; but although the navigational charts, tide predictions and marine meteorological atlases have reached a very high standard, and the marine biological stations and fishery laboratories have made great contributions, some aspects of the subject have received too little attention, and there are many questions of primary importance which cannot yet be answered. Anyone seeking to further some aspect of navigation, fisheries, coastal engineering or meteorology by applying information about variation in currents, deep-water movements, transfer of water from one layer to another, waves, or energy interchanges between the water and atmosphere, is likely to find the available information quite inadequate for his purpose. Such disappointments have led to the expression of serious doubt as to whether academic studies of sea conditions could ever be useful to practical problems.

There is, however, growing realization that insufficient determination in the pursuit of the basic studies is the cause of such failures. The satisfactory state of our knowledge of the tides is due to systematic collection of exact information about the forces which raise them, and energetic theoretical and practical

* Annual Report of the National Institute of Oceanography, 1949–50. Pp. 48. (Cambridge: At the University Press, 1951.) 5s. net.

study of their effect on seas of different size and shape. The less satisfactory progress in the investigation of other types of water movement can be attributed partly to a lesser demand for information, partly to the problems being less attractive to theoretical workers, because the forces, in contrast to the tide-raising forces, are not regular and capable of exact specification, and also because theory and observation have not gone sufficiently hand in hand. The theoretical workers have had to over-simplify the problems to make a start, and the observations, usually made in the course of some independent investigation, have been more suitable for statistical averaging than for elucidation of the primary factors. There is still need for survey work and the accumulation of facts, but the most urgent requirement is for new theoretical and experimental approaches to allow more certain interpretation of past and future measurements.

The National Institute owes its existence to the growing feeling that much can be done by concerted and systematic work to improve our knowledge of the basic processes in the sea, and that Great Britain should play a part in keeping with its tradition of interest in the oceans and their navigation. The title implies no pretension to be doing more important work than other marine laboratories in the United Kingdom and Commonwealth countries, but rather that the Institute will be concentrating on basic tasks of use to all. The future home of the Institute will be near London, chiefly to make it easier for the staff, which will include representatives of all branches of science and covering an unusually wide range of interests, to keep in touch with recent developments. To have the headquarters away from the sea is not a serious disadvantage since most of the work is likely to be done in deep water, and facilities for coastal observation can readily be arranged, often in fruitful co-operation with some authority interested in the particular problems.

It will clearly be some years before the plan can mature. Young men with good qualifications, especially in mathematics, physics and zoology, and sufficient enthusiasm to apply their specialist knowledge to the comparatively ill-defined problems of oceanography, are needed to join the existing staff recruited from the Discovery Investigations and the Royal Naval Scientific Service. There will be difficulty about accommodation until the Institute is settled in its own building. Nevertheless, good progress is being made. The *Discovery II* sailed from Plymouth on May 10, 1950, the chief aim of the voyage being to fill certain gaps in the general survey of the Southern Ocean. The *William Scoresby* has been marking whales in the South Atlantic and Indian Oceans, trying new methods of fishing off the east of Cape Province, and making a detailed study of the special water and biological conditions in the Benguela current. In the study of whaling and of the factors which influence the breeding, growth, abundance and distribution of deep-sea plants and animals, the Discovery Investigations will set the Institute going, and the extensive collections and observations available from all parts of the Southern Ocean at different times of the year are excellent material for the study of many of the physical as well as biological and interrelated problems. The oceanographical group of the Royal Naval Scientific Service has been mainly concerned with the study of waves and associated phenomena and with induced electric currents in the sea; but this is being extended to the wider investigation of all the factors which govern the transfer of energy to the oceans and its gradual dissipation in large- and small-scale water movements, which are the most urgent physical problems. A good deal of experience has been gained in the development of new measuring and analysing apparatus utilizing recent advances in scientific and technical methods.

One of the intentions is to help to provide facilities to enable, and perhaps attract, academic workers to study marine physical problems, in the hope that they may prove as effective as those which attract zoologists to the marine biological stations. At first it will be difficult to see that all aspects of the subject are given due attention; but the organization has to grow, and satisfying results are likely to be obtained more quickly by building on the work which is in hand than by starting off with too rigid a plan. The Institute is fortunate in being able to draw on the experience of members of the Discovery Investigations and of the oceanographical research group of the Royal Naval Scientific Service, and on this firm basis it should quickly establish itself as a body of international repute.

CYTOLOGY AND EVOLUTION OF FERNS

Problems of Cytology and Evolution in the Pteridophyta

By Prof. I. Manton. Pp. xi+316. (Cambridge: At the University Press, 1950.) 45*s*. net.

THE publication of this work establishes another milestone in the history of botany. In spite of the modest title, this book stands forth as a unique achievement on the basis of objectives attained and difficulties overcome. Not that the last word has been said about the evolution of the ferns—indeed, the author makes no such claim; but much new light has been shed on the relationships, phylogeny and evolution of the ferns and their allies by means of the cytological approach. To have accomplished this, in spite of the large numbers of the chromosomes which are so characteristic of these plants, is evidence not only of untiring determination and devotion but also of unusual ability in devising special techniques for overcoming obstacles. It is because of these cytological difficulties that hitherto there has been almost no dependable information on the chromosome number of the Pteridophyta.

Prof. Manton's method of attack has not been limited to the study of chromosome numbers alone. On the contrary, she has made the fullest possible use of the evidence provided through the cytogenetic study of polyploids and hybrids, and, in the light of these studies, she has been able by chromosomal analysis to reveal the true nature of numerous puzzling forms. Although circumstances prevented

the carrying out of the large programme of genetic research which had been planned, still the results achieved through the cytological and cytogenetic approach throw a flood of new light on evolutionary problems in the Pteridophyta.

Following two excellent introductory chapters on "Method" and "Problem" respectively, the next five are devoted largely to the British species of ferns, some of which are very common but which nevertheless turn out, upon cytogenetical analysis, to be surprisingly complex. Outstanding among these are the polyploid series in *Osmunda*, and the genus *Dryopteris*, including the male fern, *D. Filix-mas*. The phyletic situation in "*Dryopteris*", as that genus has been broadly construed in the past, is interesting. According to the author, "it may be stated that not one but probably at least four distinct genera are actually represented, some of which, notably *Dryopteris* in the narrow sense and *Thelypteris*, seem to have come from widely different sources and to owe their present resemblance to parallel evolution". Furthermore, "within the curtailed genus *Dryopteris* polyploidy and hybridization are rife . . ."; such information as this must have a profound effect upon future taxonomic concepts in these groups.

Chapter 8 reports an investigation of the common polypody, *Polypodium vulgare* sens. lat., a holarctic group which turns out to include at least five separate species—another contribution of importance to taxonomy. Chapter 9 reports studies on three non-British wild hybrid ferns: (1) *Scolopendrium hybridum*, an endemic of certain Adriatic islands, is a tetraploid and one possible parent, *S. hemionitis*, is diploid; (2) some Swedish *Woodsia* hybrids involving *W. ilvensis* and *W. alpina* are triploid, and their chromosome pairing suggests that the diploid *W. ilvensis* is one parent of the tetraploid *W. alpina*; (3) triploid plants of *Polystichum illyricum* from Switzerland show by their chromosome pairing that *P. Lonchitis* is one parent of *P. aculeatum*, and, since the other possible parent is *P. angulare*, it is hoped that the tetraploid *P. aculeatum* can be synthesized from a hybrid between these two species. Such studies again throw much-needed light on the true genetic relationships of these puzzling forms.

Chapters 10–12 report investigation on apogamous ferns with emphasis on the evolution of various species. Since apogamy is a widespread phenomenon, and since rather definite conclusions have been reached concerning the evolutionary significance of apogamy in the flowering plants, Prof. Manton's conclusions about the role of apogamy in the evolution of ferns are of special interest. Notable among her generalizations is the conclusion that apogamy is polyphyletic in origin, that it is not cytoplasmically controlled and is not due to a single Mendelian factor. Her general conclusion is that "hybridization is a cause and not merely the occasion for the manifestation of apogamy, whatever the physiological mechanism may be". She emphasizes the prevalence of parallel evolution in numerous phylogenetic lines in which apogamy has occurred. She also finds that induced apogamy differs from obligate apogamy in its nature and cause.

The remainder of the book, except the general, concluding chapter and the appendixes, deals with representatives of the other great groups included with the ferns in the Pteridophyta. Chapter 13 reports cytological study of fourteen species of *Equisetum*, which are equally divided between the two subgenera. All the species of both subgenera appear to have the same chromosome number, $n = 108$. The genus is ancient and stable; yet evidence of hybridization was found in three species. Chapter 14 is a brief discussion of the cytology of two wild species of *Psilotum* and one of *Tmesipteris*. In the former the diploid number is either 104 or 108; but tetraploid sporophytes are also known to occur. In the latter the sporophytic number is between 400 and 500. "It is conceivable that these high numbers are the end-products of very ancient polyploid series which relate back to simple beginnings even in those groups such as *Equisetum*, in which no direct traces of polyploidy yet remain." Chapter 15 discusses eleven species, representing three genera, of the lycopods; and Chapter 16 presents important information on the chromosomes of three different families of ancient ferns.

The general review and conclusions reached in the final chapter will be of interest to all biologists. As might be expected, evidence is found that the Pteridophyta have proceeded further in their evolution than the flowering plants. This evidence includes, among others, the comparison of polyploidy and diminution in chromosome size. It is suggested that the evolutionary potential of the Pteridophyta is running down, and that cytological conditions in themselves can be factors which cause a slowing down of evolutionary activity. This in turn leads to the forceful philosophical suggestion that evolution is a phenomenon for which no cause need be assigned other than the fundamental instability of living matter.

Author and publisher are to be congratulated on the attractive format, the many excellent illustrations, the helpful appendixes, bibliography and index.

ERNEST B. BABCOCK

INLAND WATERWAYS OF GREAT BRITAIN

British Canals

An Illustrated History. By Charles Hadfield. Pp. 259+8 plates. (London: Phoenix House, Ltd., 1950.) 16*s*. net.

The Canals of England

By Eric de Maré. (London: Architectural Press, 1950.) 18*s*. net.

The Inland Waterways of England

By L. T. C. Rolt. Pp. 222+48 plates. (London: George Allen and Unwin, Ltd., 1950.) 21*s*. net.

THE Industrial Revolution in Great Britain was initiated largely through the utilization of water for power and transport: water-wheels drove the machinery of the early factories; and canals provided a means of transport, more economical and safer than the roads of eighteenth-century Britain. With the advent of steam power, the water-wheels were superseded and the railways eclipsed the canals. But though the canals languished, they were never entirely displaced; and perhaps, indeed, the pendulum swung too far, and traffic was lost to the canals which they should have retained. For this, a variety of factors were responsible. The canal companies themselves lost heart and became unenterprising; they failed to standardize their waterways and never made any real attempt to integrate the various local undertakings out of which the canal system had grown up, and they did little or nothing to foster through-

traffic. Unlike the railways, they never provided any clearing-house system and, with few exceptions, were reluctant to act themselves as carriers. The railway companies came to control something like one-third of the total canal mileage, having been forced in their early days to buy up canals as the price of silencing opposition, and they were apathetic towards improving a rival and—in their eyes—an outmoded form of transport. It is not surprising, therefore, that the Royal Commission on Canals of 1906–9 could declare that, with few exceptions, waterways had made neither improvements nor progress since the middle of the nineteenth century.

During the past few years, there has been a remarkable revival of interest in canals among the general public and, in particular, among those attracted by the pleasures of canal cruising, as is shown by the rapid growth of the Inland Waterways Association and the rally of boats last summer at Market Harborough. The almost simultaneous publication of three books on the subject of canals is a sign of this increased interest, for until now there was no such adequate literature of recent writing. Indeed, apart from Susan Woolfitt's "Idle Women" and L. T. C. Rolt's earlier best-seller "Narrow Boat", there has been little written since the publication of the Reports of the Royal Commission on Canals stimulated interest in the subject for a few years before the outbreak of the First World War. The three books now published fill an important gap in the literature of transport, and between them they provide a wealth of fascinating information, the more valuable as they constitute a documentary record in word and picture of a way of life and a folk-art now rapidly passing. Each of the books is exceptionally well illustrated, and they are not, as might be thought, competitive with each other; rather they complement one another, each emphasizing and illustrating particular facets.

In the first book, Charles Hadfield provides a full-length history, not perhaps entirely consecutive but nevertheless accurate and scholarly, drawing much of his information at first hand from canal company minute-books and records. Among the many interesting subjects discussed by Mr. Hadfield is his account of the passenger-carrying activities of the canals in the early years of the nineteenth century. He relates, for example, that in 1836 nearly 200,000 passengers travelled on the Forth and Clyde Canal and that in 1835 more than 370,000 passengers were carried by the Glasgow, Paisley and Ardrossan Canal. Sleepers were provided on some of the canal services, excursions were run at very low fares, and speeds of 8–12 m.p.h. were attained. "It was found," he says, "with specially built light boats that if speed were increased beyond the normal three or four miles an hour, a wave was built up in front of the boat, but that a further increase of speed enabled the boat to pass the wave, rise in the water and to travel at a speed of eleven to twelve m.p.h."

In the second of these three works, Eric de Maré explains how canals are constructed, how they work, summarizes their history and makes succinct recommendations for canal betterment. He is particularly happy in his descriptions of canal bridges and canal-side inns and cottages and of similar examples of the fine functional architecture associated with canals. The photographs of these and the accompanying thumb-nail descriptions are a sheer delight. Equally fascinating are the photographs of canal boat-people and their vessels.

The third work, by L. T. C. Rolt, shows him to be an enthusiast for canals and all connected with them, down to the minutiæ of lock-building, maintenance and the boats. He is especially persuasive about the attractions of canal cruising and the need for opening up canals to pleasure travel. Though he looks back nostalgically to the old days and has few good words for our modern way of life, he writes in an agreeable and persuasive manner so that even his prejudices—of which he has many—are stimulating. His knowledge of canals is encyclopædic, and in this book he summarizes the history of canals, describes their notable engineering works, explains how the waterways are maintained and discusses traffic working, both past and present. His description of the construction of locks, canal maintenance, boat building, bridge building and canal customs is of great value as a contemporary record of much that is fast passing away. The book, with its superb collection of photographs, is thus most opportune. He is at his best in describing the traditional crafts, customs and working methods of the canals, such as the boat-building yards with their "clatter of caulking mallets, the pungent aroma of hot tar, pitch and fresh oakum", or the canal horses, "their tackle resplendent with brass ornament, painted feeding bowl and brightly coloured wooden 'bobbins' on the traces to prevent the latter from chafing". He describes how elm is used for the flat bottom of wooden canal boats since it is constantly submerged, whereas oak is used for the planking and is tarred for preservation. The elm bottoms are not treated in any way but are allowed to absorb water like a sponge. Constantly saturated in this way, they will last for years; but if allowed to dry out thoroughly, they would soon crumble to powder. He has a gift of vivid description, as when he tells of ice-breaking during a severe winter when the ice-breaker's approach is heralded by the cracking, splintering and rending din of its passage while the unbroken ice ahead reverberates like a drum; "then the straining, steaming team appears round the turn, moving at that urgent pace which is almost a trot, and finally the boat itself comes into view, rolling almost gunwale under in a flurry of spray and shattered ice as the red-faced crew swing in unison".

Though these three books between them cover a wide field, they are for the most part concerned with the history and present position of the canals. What of the future? Every Royal Commission and Government committee which has investigated the canal problem has recommended unification and amalgamation of the canal system. This has at last come to pass through the nationalization of transport, and a re-assessment of the whole subject of inland waterways is now due. At the time when this review was being written, the British Transport Commission issued a statement of policy regarding the integration of the inland waterway services with those by road and canal. The Road Haulage Executive is to provide feeder and distributive services at suitable points on the waterways, and there is to be co-operation between road, rail and inland waterways in the use of existing terminals and in the promotion of new joint terminals on modern lines under single control. Such modernization is long overdue; on some canals cranes which are 150 years old are still being operated, and according to Mr. de Maré the original hand pulleys are still in use on the Bridgewater Canal. The statement of policy also lays down the types of traffic for which inland waterways are especially suitable: for example, carriage of petroleum and

liquids in bulk; import and export traffic, especially where direct transfer between ship and canal-boat is possible; bulk traffic, and traffic between waterside premises. This is a good beginning, but it is to be hoped that the statement of policy will be followed up and that the Docks and Inland Waterways Executive will now sponsor a detailed, practical investigation of the present state and future possibilities of inland water transport.

K. G. FENELON

RECLAIMING THE DESERT

Men against the Desert

By Ritchie Calder. Pp. 186+27 plates. (London: George Allen and Unwin, Ltd., 1951.) 12*s.* 6*d.* net.

MR. RITCHIE CALDER, the science editor of the *News Chronicle*, was sent by Unesco to North Africa and the Middle East to report on what is being done to reclaim the deserts. The strange aura of romance and mystery that surrounds the desert attracted much attention to the assignment, which was reported (according to the publisher's note) in thirty-two countries. A popular belief that some of the vast empty deserts could be used for helping world food production overtake world population contributed further to the widespread interest aroused by Mr. Calder's journey. It took him from Algiers deep into the Sahara, across North Africa to Cairo and Sinai, then (since access to Israel from Egypt is impossible) to Iraq, Persia, Cyprus and thence to Israel but not to Jordan, which was barred to Mr. Calder because he had an Israeli visa on his passport.

The journey thus covered the grounds occupied by many of the oldest cultures in the world, of which only that of Egypt still flourishes. The others have been partly or completely submerged beneath the desert sands. The question Mr. Calder hoped to answer was: Could these lands again be made to support a hundred people where now they only support one?

The answer he obtained was a qualified affirmative. Mr. Calder is a good journalist and brought unbounded enthusiasm to his task. From the first to the last page his book makes fascinating and absorbing reading. In every country he found enthusiasts to whom the reconquest of the desert had become almost a divine mission and who usually encountered one insuperable obstacle to the accomplishment of their mission—apathy on the part of either the authorities or, more commonly, of the people who were to be saved. The truth seems to be that the deserts are seldom worth reclaiming. They were conquered at a period when irrigated agriculture was the only kind of intensive agriculture known to mankind, and they were abandoned when agriculture became possible in moister lands. In most cases money could now be more efficiently spent on reclaiming waste land in already densely populated countries—England, for example. In North Africa reclamation involves not merely the bringing of water on to the land and the growing of trees and crops, but also the establishment of the rule of Cain in the country of Abel. In Algeria, Tripoli, Cyrenaica and Egypt, Mr. Calder reports that great works are being organized to throw back the desert, and all credit is due to those who are carrying them out; but if and when successfully completed they will be but as a drop in the ocean. As a contribution to the global food supply their effect will probably be ephemeral, because the sons and daughters of Cain have a way of multiplying up to and beyond the limit their land will support.

In Israel, however, and to a lesser extent in Iraq and Persia, desert reclamation is a matter of urgent practical politics. Those beings whom Mr. Calder calls "the scientists" and who correspond to the gods who wrought wonders in former ages are being called upon to shower their blessings on mankind. Iraq and Persia have in their oil great wealth, some of which can be diverted to restoring the productivity of the land by modern adaptation of ancient methods. Israel has no mineral wealth, and her greatest resource in conquering the desert is the ingenuity of her people, and particularly of "the scientists" who are not only planning great irrigation and hydro-electric schemes but also are working on the large-scale desalinization of salt water by ionic exchange and by distillation through nylon. Promising experiments are being made to use the opacity of flake nylon to light and heat to reduce evaporation from reservoirs. There seem to be possibilities that nylon may become a key material in the conservation of water in Israel, and schemes are being considered for the large-scale cultivation of the castor-oil plant as a source of raw material for nylon manufacture. The great plans for the "Jordan Valley Authority" first put forward by Dr. W. C. Lowdermilk, whereby the waters of the Jordan would be almost completely used for irrigation, are in abeyance owing to the conflict between the Jews and Arabs; but the reclamation of the Negev, where the Israeli government hopes to settle some of its present surplus population, is proceeding. What is being done in Israel shows what can be done in desert reclamation if the will and the need for it are there. But the impression left by Mr. Calder's book is that in most of the other countries which he visited one or other of these essential stimuli is lacking.

G. V. JACKS

ANALYTICAL CHEMISTRY: SCIENCE OR ART?

Chemistry of Specific, Selective and Sensitive Reactions

By Dr. Fritz Feigl. Translated by Prof. Ralph E. Oesper. Pp. xiv+740. (New York: Academic Press, Inc.; London: H. K. Lewis and Co., Ltd., 1949.) 13.50 dollars.

QUITE apart from his considerable output of original papers, the especial significance of Prof. Fritz Feigl's contributions to analytical chemistry was made abundantly clear on the publication in 1931 of his great work "Qualitative Analyse mit Hilfe von Tüpfelreaktionen". This book has unquestionably exercised a profound influence on the development of microchemistry, for by demonstrating the feasibility of carrying out chemical tests of high sensitivity and selectivity even on the microgram scale it may be said to have founded a philosophy from which has derived the methods and techniques of qualitative and quantitative microchemistry and ultra-microchemistry without which the recent spectacular advances in inorganic chemistry—especially among the heavier elements and radioactive isotopes—could never have been achieved.

In the admirable English translation by Dr. Janet Matthews, the practical part of Prof. Feigl's book

reached a wider circle of readers under the title "Spot Tests" (first edition, 1937). Though published separately much later, there must have been many who deplored the omission from this English text of the 128-page "Theoretischer Teil" of the original work, which discussed in such a masterly and stimulating way the factors governing specificity, selectivity and sensitivity, and the relationships between colour, solubility, fluorescence, etc., and the constitution of the substances under investigation. The present volume may be said to have been developed from this section of the original work, and it has clearly been written with three groups of readers in mind: the first includes those who wish to understand the chemistry and physical chemistry underlying contemporary analytical procedures; the second those who are actively engaged in research and developing new methods in analytical chemistry and related fields; and the third group includes those interested in chemistry primarily from the experimental angle.

On the annexation of Austria by the Nazis, Prof. Feigl lost his chair at the University of Vienna, and in the subsequent flight from Europe in 1941 he lost the whole of his laboriously gathered material. The present volume is thus more than a work of ripe scholarship, for it reflects the pertinacity, the industry and the great courage of its distinguished author. Still more perhaps it breathes enthusiasm for the subject in every page. After describing the role of reaction conditions in defining the sensitivity, selectivity or specificity of a chemical test, a lengthy chapter deals with complex and co-ordination compounds and the part they play in analytical chemistry. Here, as elsewhere throughout the book, false distinctions between principal and subsidiary valencies are still drawn, nitrogen appears as pentavalent, sterically impossible formulæ are uncritically proposed and the general treatment of valency theory is seriously outmoded. The urge to devise structural formulæ for substances (for example, CHI_3,24S) which are almost certainly lattice-compounds, and to infer from the empirical formula of a solid phase the nature and stability of ions present in solution with it, is regrettably shared by many of the authors of the text-books to which Prof. Feigl refers.

A most suggestive chapter on masking and demasking of reactions is followed by a discussion of catalysed and induced reactions and the effect of complex formation on increasing reactivity in certain cases. Nearly two hundred pages are then devoted to a very comprehensive review of the effect of atomic groupings in controlling the specificity of organic reagents for use in inorganic analysis; a shorter section deals similarly with reagents for organic analysis. Regularities and anomalies in the solution of materials in indifferent solvents occupy thirty pages, and not surprisingly this raises more points than it solves, as indeed does the next chapter dealing with the effects of size, shape, substitution and constitution on the solubility and salt-forming capacity of organic reagents.

Prof. Feigl is an outstanding 'picker-up of unconsidered trifles' and has a genius for adapting the most obscure and recherché observation to an elegant and specific analytical procedure. This is admirably illustrated in the long and very informative chapter dealing with surface effects in analytical chemistry, still more so perhaps in Chapter 11 dealing with the genetical formation of materials and the quite fascinating subject of topochemical reactions. The concluding chapter, on the use of fluorescence effects and photochemical reactions, is included for the sake of completeness, though the subjects are dealt with better and at greater length elsewhere.

One is seldom aware that this is a translation, and for this we must congratulate Prof. Ralph Oesper. There are, of course, many errors of fact in this book, and the reader may disagree—even violently—with many of the theoretical interpretations which the author puts forward; but he cannot fail to be stimulated. Prof. Feigl has shown himself to be a great artist in the field of analytical chemistry; and the fact that he brings his great reputation and authority to demonstrating that it is no mere technology but a sadly neglected science is a matter for which we must all be grateful. This unique and pioneering book must certainly find its way into the hands of every serious analytical chemist; but it should be diligently perused no less by every organic, inorganic and physical chemist, who may thereby become aware of the many and great problems which await the exercise of his particular talents and outlook.

H. Irving

MICROGRAM ANALYSIS

Quantitative Ultramicroanalysis

By Prof. Paul L. Kirk. Pp. vii+310. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1950.) 40*s*. net.

Some ten or fifteen years ago, text-books on microchemical analysis came forward frequently for review, and it was a normal gambit to note that these dealt with new techniques. Some indication of the rapid expansion of this branch of chemistry may be gained from the realization that this is the first text-book devoted entirely to techniques which stand in much the same relation to normal microchemical techniques as these latter do to the classical analytical procedures.

Prof. P. L. Kirk is well qualified to present an account of these latest small-scale methods, since he was closely associated with the development of many of them, both in his earlier biochemical work, and then in his post with the Manhattan Project, where he was in charge of chemical control methods. As most chemists are now aware, the development of adequate microgram procedures was of vital importance in atomic energy work.

In this book the methods described are almost exclusively volumetric, gasometric or colorimetric, and are largely confined to the biochemical field. Gravimetric methods receive little attention, and there is little discussion of instrumental methods other than absorptiometric.

In spite of this severe restriction, the book offers a welcome foundation for work in the microgram range. Analytical chemists and biochemists find an increasing need for these techniques. They have here a valuable introduction to basic apparatus and methods which, more particularly in the volumetric field, is authoritative, full, clear and timely. It seems likely, also, that a considerable proportion of the rather specialized biochemical apparatus and methods may readily be adapted to more general application. Finally, the contents of the book will undoubtedly stimulate many workers to develop to the full these fascinating methods of analysis which are at present only in their infancy.

Geology for Engineers

By Prof. Joseph M. Trefethen. Pp. xi+620. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1949.) 29*s.* net.

OF the twenty-two chapters in this book, only the two on geophysical exploration and on dam sites and reservoirs have special reference to engineering. There are incidental data in other chapters which are of some interest to engineers, but most of it could be regarded as a first-year course in geology for American students. A surprising matter to include is an account of an eruption of Mount Etna in 1928, reproduced from the *New York Times*. Whole chapters, such as that on metamorphic rocks, earth history and on the atmosphere, with its classification of clouds, appear to have no special interest for engineers and could well have been omitted. So could also the chemical formulæ of rock-forming minerals and the chemical equations which are supposed to represent what takes place in the weathering of rocks. An engineer might also be spared the cumbrous and unnecessary triangular diagrams illustrating the classifications of soil and sedimentary rocks.

The line diagrams are poor and of little value for their purpose. The references are almost exclusively to American sources and are of little interest to British engineers; this is particularly evident in Appendix 1, sources of geological information. The elaborate tables on the physical properties of some common minerals, including cancrinite, idocrase and andalusite, and that on rocks, are unnecessary where a practical course is provided.

Seven full-page plates are included, but they have no plate numbers, and there is no description of any of them. One of these, an air-photograph of a dissected anticline showing the development of 'flat-irons', is of considerable interest, and one would have liked to know the locality where it was taken. The best feature is the inclusion of thirteen coloured American topographical maps showing a variety of geological land forms.

O. T. JONES

Tissue Culture Technique

By Gladys Cameron. Second edition, revised and enlarged. Pp. xii+191. (New York: Academic Press, Inc., 1950.) 4.20 dollars.

TISSUE culture is more often learnt by apprenticeship than 'from a book'; but Dr. Gladys Cameron's treatise is about as good as a technical manual of the sort can be. Its keynote is simplicity and straightforwardness. It is quite untainted by the *mystique* that is apt to surround procedures which (like photography and histological technique) are still to some extent empirical in standing; and, without belittling the difficulties of an elaborate technique, Dr. Cameron makes it clear that tissue culture can be practised with the resources of an ordinarily well-equipped laboratory. The publication of a new and thoroughly revised edition is justified by the major advances that have taken place in tissue culture practice since the publication of the first edition—the development of 'massive' culture techniques and of plasma-free cultures, the use of antibiotics as antiseptics, the provision (in America) of frozen-dried culture media, and so forth.

The general movement of tissue culture practice has been towards simplification, mechanization and functional analysis; it has long since fought free of its traditional enslavement to histology, although great things are to be expected from the electron microscopy of cultivated cells. Twenty years ago it seemed as if orthodox tissue culture was to degenerate into a very minor adjunct of laboratory practice. To-day, one can look forward with reasonable confidence to the prospect of fundamental advances. It is to be hoped that later editions of Dr. Cameron's monograph will keep pace with them in due course.

Fishing Ways and Wiles

By Major H. E. Morritt. New and enlarged edition. Pp. 192. (London: Jonathan Cape, Ltd., 1950.) 10*s.* 6*d.* net.

OUT of the rich experience of more than sixty years of angling, Major H. E. Morritt has fashioned a book that will delight everyone who has had the luck to fish the tumbling trout streams of the north of England.

Like the author, I have done most of my trout fishing in the fast-flowing upper reaches of the River Tees. I found the book packed with river-lore which, had I known it before, would surely have doubled my catches.

The author takes the trouble to explain those practical points which so many writers of angling books avoid—where trout are most likely to feed when the water rises and falls, the best speed at which to work a wet fly or a sea-trout lure, and so on.

Major Morritt, who owns the famous "Meeting of the Waters" stretch of the Tees at Rokeby, is no fly purist. His purpose is to help the reader to catch fish by any fair means. He does not decry fishing with minnows. He admits he gets great pleasure out of worm-fishing.

The only fault I can find with the author is his statement that every trout caught on a minnow is likely to be a cannibal which would be better out of the river. In my experience any trout can be caught on a minnow. Fishing with a two-inch minnow-bait I have frequently taken trout less than six inches long.

The volume, which is an enlarged re-issue of a book Major Morritt wrote twenty-one years ago, carries only one of the author's fine paintings. I could have done with more.

CHAPMAN PINCHER

La biologie des diptères

Par E. Séguy. (Encyclopédie entomologique, 26.) Pp. 609+10 plates. (Paris: Paul Lechevalier, 1950.) 4000 francs.

THE most recent volume to be added to the "Encyclopédie entomologique" is this one by E. Séguy, which deals with the biology of the Diptera, a group of insects divided into 120 families and comprising more than a hundred thousand known species. The author claims that since the time of Redi some sixty thousand memoirs on the biology of Diptera have been published. In view of their immense diversity in form and in habits, that is not surprising; but it means that the author has been faced with an enormous task of condensation. On the whole, this has been very successfully achieved. In presentation the book is concise and pithy, with not a word wasted in its six hundred pages. It contains a fair amount of physiology as a background to the natural history of the group and is copiously illustrated, many of the figures being original. It is well provided with references.

NOBEL AND HIS PRIZES

IN 1950 the Nobel Foundation celebrated its fiftieth anniversary. An account of the ceremonies marking the event has already appeared in *Nature* of January 13 by Prof. G. Hevesy, himself a Nobel prize winner, together with some details of the book before us* ; but not much was related by him of the man Alfred Nobel. Born in 1833, son of a somewhat unsuccessful but brilliant technician, he only received one year's schooling, at the age of eight, and no university education. Unusually intelligent, he was a dreamy, introspective youth ; private tuition had made of him by the age of sixteen a remarkable linguist and a scientifically trained chemist. An improvement in the manufacture of nitroglycerine was followed by the invention of dynamite, and he became at an early age the head of a world industry. He never took root in a home but spent most of his time in railway carriages, steamship cabins and hotels. A strong disinclination to allow anyone to become too close to him was offset by a strong need for an intimate friend on whose devotion he could rely in all circumstances. Inner contradictions between his mental and emotional life were typical of him and are illustrated by the fact that as a world leader in one branch of the armament industry he founded a prize for the champions of peace.

Alfred Nobel died in 1896. His will was very simple. The capital of his estate was to form a fund, the interest of which was to be distributed annually in the form of five prizes : one part each to the persons who shall have made the most important discovery or invention in the fields of physics and chemistry, these two prizes being awarded by the Swedish Academy of Science ; one part to the person who shall have made the most important discovery in the domain of physiology or medicine, this to be awarded by the Caroline Institute in Stockholm ; one part to the person who shall have produced the most outstanding work of an idealist tendency in the field of literature, the prize to be awarded by the Academy in Stockholm—the Swedish Academy ; and one part to the person who shall have done the most or the best work for fraternity among nations, for the abolition or reduction of standing armies and for the holding and promotion of peace congresses, this to be awarded by a committee of five persons elected by the Norwegian Storting. In awarding the prizes no consideration was to be given to the nationality of the candidate.

The will was simple : to implement it was not easy. There were at first difficulties with the family, smoothed over by the firm and generous support to the will given by Emmanuel Nobel, the eldest of a family of nephews and nieces living in Russia. Then there was a not unnatural hesitation on the part of the awarding bodies to take on the novel responsibilities placed upon them by the will. These were in all cases overcome, and it will now be generally accepted that the statutes of the Nobel Foundation represent a most satisfactory scheme for carrying out the founder's intentions.

One word may be added as to the possible genesis of the various prizes. A clause in the will that preference should be given to those who "shall have conferred the greatest benefit on mankind" is reminiscent of the terms of award of the Rumford Medal of the Royal Society. Nobel's interest in literature was very deep. He had been deeply impressed by Shelley, and his outlook was deeply religious. In his worship of a God of peace and universal love of men, he adopted that atheism of Shelley which was essentially so close to Platonism and to basic Christianity. His support of a children's hospital and an earlier proposal to found a medical research centre in Paris, partly for blood transfusion, show that his coupling of "physiology and medicine" was not accidental but that he was interested in discoveries of a purely scientific nature as well as in those having an immediate practical value ; while his Peace Prize, though not aimed directly at disarmament, which, he recognized, must come slowly, was rather based on the idea that peace would come when all nations agreed to take up arms together against any nation which first violated peace and began a war.

Reading the accounts of the work of the prize committees in the natural sciences, we receive in concentrated form the history of the principal developments of these sciences over the past fifty years, both new discoveries and achievements of a different kind. This is particularly true of the section on the Prize for Physiology and Medicine, where much more is told of the reasons underlying the particular awards and of the competing subjects that were rejected than is given in the sections on the Prizes for Physics and for Chemistry. Each prize committee has its own rules as to what bodies or individuals are allowed to nominate candidates, with reasons given, for an award. The task of narrowing down the list each year to the final award is in general a very heavy one. At least eight months in each year is spent in investigation, examination and discussion of the works of the candidates nominated. The high regard in which Nobel prizemen are held the world over is a measure of the success and impartiality with which the task has been carried out.

The Prize for Physiology and Medicine has been divided between two candidates, generally for work in closely related fields, more frequently than any of the other prizes. During the fifty years under review, as many as 872 names were submitted to the electors —on an average more than 17 new names in a year. The number nominated varied considerably from year to year, from 89 in 1937 to 23 in 1944. The phrase "the domain of physiology or medicine" has been interpreted to mean "all the theoretical as well as the practical medical sciences"—such branches of physiology as fall outside the medical sphere have not been taken into account.

Awards for successes in the unremitting war against disease naturally figure largely in the list, from the first prize in 1901 to Behring for serum therapy and its application to diphtheria. Malaria (Laveran and Ross), typhus (Nicolle), tuberculosis (Koch), and pernicious anæmia (Whipple, Minot and Murphy) come in as specific cases, while more general awards were made for immunology and for anaphylaxis ; the special importance of the human blood groups in blood transfusion was recognized in the award to Landsteiner. In chemotherapy, prontosil,

* Nobel : the Man and his Prizes. By H. Schück, R. Sohlman, A. Österling, G. Liljestrand, A. Westgren, M. Siegbahn, A. Schou and N. K. Stahle. Edited by the Nobel Foundation. Pp. 620. (Stockholm : Sohlmans Förlag, 1950.) 30 kr.

penicillin and DDT were represented, while Finsen's phototherapy for lupus also drew an award. Hormones and vitamins bring into view thyroid diseases (Kocher) and the discovery of insulin (Banting and Macleod), while genetics and the function of chromosomes in heredity (Morgan) with the nature of embryonic development form one more branch of the domain covered by the prize. Turning to the more purely physiological field, we find represented the nervous system and the sense organs, digestion, circulation of the blood, respiration and excretion, the chemical structure of the body and intermediary metabolism. In much of this work one realizes how closely physiology and chemistry are linked, and one looks, not in vain, for awards of the Nobel Prize in Chemistry for subjects closely akin to some of the awards in physiology. Biochemistry clearly represents a field of interest to two sets of electors to Nobel prizes.

But let us turn aside for a moment to consider the Nobel Prize in Literature. Here we find a very great reluctance on the part of the awarding body, the Swedish Academy, to accept the responsibility laid on it: it was only the argument by Wirsén that its refusal would deprive leading men of letters of the financial reward and exceptional recognition which Nobel had in mind, which finally persuaded the Academy to accept. As it was, it had to face a storm when for various reasons Tolstoy was not chosen as the first prizeman (as a matter of fact he had never been nominated). The difficulty that faced the committee in judging the relative importance of candidates can be well understood if we consider some of the pairs between whom the choice finally lay in a given year; the name of the prizeman is given first in each case: Theodor Mommsen and Herbert Spencer; Eucken, Swinburne and Lagerlöf; Benavente and Yeats; Yeats and Hardy; Spitteler and Brandes; Sinclair Lewis and Dreiser. Carducci was one of the very few prize-winners who was chosen unanimously: the average age of the prize-winners is sixty-two, Mommsen being the oldest at eighty-five and Kipling the youngest at forty-two. France has received the highest number of the literature awards.

To return to scientific subjects, we take next the Nobel Prize for Chemistry. The first six awards were made to the elder statesmen in the chemical world when the Prize was founded: Van't Hoff, the founder of stereochemistry and the author of the laws of osmotic pressure, received the first prize. He was followed by Emil Fischer for his investigation into the structure of the sugars, and another German organic chemist, von Baeyer, the 'Grand Old Man' of organic chemistry; Arrhenius was elected as a prizeman for his work on electrolytic dissociation, William Ramsay for the discovery of helium, neon, krypton and xenon, Moissan for the isolation of fluorine and the introduction of the electric furnace. After these early awards, the Prize was given for work carried out almost entirely in the present century, and the subjects have been grouped conveniently under eight heads.

Under radioactivity and atomic chemistry we find the names of Mme. Curie for the discovery and isolation of radium, Rutherford for his work on the disintegration of the elements and the chemistry of radioactive substances, Soddy for his study of the origin and nature of isotopes, Aston for the results obtained by his mass-spectrograph and his discovery of the whole-number rule, Urey for the discovery of heavy hydrogen, Hevesy for his work on tracer-elements, Joliot and Mme. Joliot-Curie for their synthesis of new radioactive elements, and Hahn for his discovery of the fission of heavy nuclei. To complete this story we must look to the awards made for the Prize for Physics.

But first we must examine other heads under which awards were made in chemistry. The constitution of organic compounds and biochemistry obviously are subjects closely linked with some of the awards in physiology. The work of Wieland and Windaus on the constitution of the bile acids and sterols respectively, that of Haworth, Karrer and Kuhn on carotenoids, flavine and vitamins A and B_2, and that of Butenandt on sex hormones are sufficient to mention in this connexion. Work on other organic compounds such as chlorophyll (Willstätter), the alkaloids (Robinson) led to awards, while work on organic processes, such as fermentation, and on fermentative enzymes, was also recognized. Nutrition chemistry appears in the case of Virtanen's fodder preservation method. Micro-analysis is represented by Pregl, colloidal and surface chemistry by Zsigmondy, Svedberg, Tiselius and Langmuir. Ostwald, Nernst and Giauque represent dynamic chemistry and thermochemistry and the behaviour of substances at low temperatures. Technical developments were recognized in the work of Haber on the synthetic production of ammonia from its elements, and in the hydrogenation of coal and the development of chemical high-pressure methods. We return to physical chemistry in the work of Debye on dipole moments and molecular structure and on the diffraction of X-rays and electrons in gases.

The first award of the Nobel Prize for Physics was to Röntgen for the discovery of X-rays. As with the other prizes, the awards in the first few years were mainly for work done in the previous century, and all but three of those nominated for the first award eventually became Nobel prizemen—the three exceptions being ruled out (1) by the nature of his researches (W. W. Campbell), (2) by the early date at which his work had been done (Kelvin) and (3) by his early death (Nordenskiöld). The close nature of the tie between the prizes for physics and chemistry is revealed in the third award, which Mme. Curie—who afterwards got a Nobel Prize for Chemistry—shared with her husband and Henri Becquerel for the study of spontaneous radiation, while in the following year Rayleigh got the Prize for Physics for the discovery of argon (and most fitly in the same year Ramsay got the Prize for Chemistry, as we have seen, for helium, neon, krypton and xenon).

The various branches in which physics has shown most vitality and progress in the past century are more closely interlocked than those in chemistry and physiology, and this is somewhat reflected in the account of the awards in physics given in the book. A few main lines can be followed through, some with obvious gaps to be supplied from the chemistry awards. Lenard's work on cathode rays was followed by J. J. Thomson's discovery of the electron. C. T. R. Wilson's cloud chamber revealed its value in the subsequent awards to Hess for work on cosmic radiation, to Anderson's discovery of the positron and to Blackett for development of the method and applications to nuclear physics and cosmic radiation. The discovery was recognized of fresh elementary particles, of which the neutron (Chadwick) has proved of immense importance. The meson was predicted successfully by Yukawa. New artificial

radioactive elements produced by neutron irradiation secured an award for Fermi, while a very powerful method for accelerating charged particles was developed by Lawrence in the cyclotron. The idea that held in certain circles at the end of the past century that physics had nearly reached a stage of completion was completely killed by the workers mentioned above.

Another line of development was linked with electromagnetic theory; Lorentz and Zeeman received the second Nobel Prize for Physics for their investigations of the influence of magnetism on the phenomena of radiation, Stark for the splitting of lines in electric fields and Michelson for his precision optical work, showing that no motion of the earth relative to the ether could be detected.

A revolutionary approach to the laws of radiation was developed in Max Planck's quantum theory. Niels Bohr's quantized atomic model led the way to most important theoretical developments, while more immediately practical results came from Einstein's discovery of the law of the photo-electric effect, Franck's and Gustav Hertz's work on collisions between electrons and atoms, Raman's on the scattering of light, and A. H. Compton's work on the scattering of X-rays in matter, and the Compton effect.

A further development, also revolutionary in character, followed from the quantum theory of radiation, which had in a sense ended the long-standing battle between the particle and the wave-theory of light. Prince Louis de Broglie applied the idea to particles of matter, and developed a theory that every particle is associated with a wave-motion —he discovered the wave nature of electrons, which was confirmed observationally by Davisson and G. P. Thomson. This work of de Broglie's in the hands of Schrödinger and Dirac led to fruitful developments of atomic theory, and to important new theorems such as Heisenberg's uncertainty principle and Pauli's exclusion principle. Dirac's work was tied up by Stern and Rabi with the magnetic moment of the proton and of atomic nuclei.

Von Laue's work on the diffraction of Röntgen rays by crystals, that of the Braggs on the analysis of crystal structure by means of X-rays, Barkla's work on the characteristic Röntgen radiation of the elements and Siegbahn's development of X-ray spectroscopy open up another chapter of research in physics.

Further, one must not forget in all this range of subjects considered by the electors as worthy of recognition O. W. Richardson's work on thermionics, the technical development of wireless telegraphy for which Marconi and Braun received an award, and also the investigations into the physical properties of the higher layers of the atmosphere which made Appleton a Nobel prizeman in physics.

We turn now to a different type of question. The award of the Nobel Peace Prize. Nobel's money, though derived mainly through explosives, was only in small part derived from military munitions, and there is no reason to doubt his sincere love of peace. He did remark in a letter to Baroness von Suttner, to whose influence the framework of the peace prize award is partly due, that his improvements in the means of destruction were more likely to make an end of war than her peace congresses. It is even more true to-day of some of the results arising from the work of many to whom awards have been made in prizes for chemistry and physics.

The first awards were made to two veteran pioneer peace-workers, Dunant, the creator of the International Red Cross, and Passy, founder of the International Permanent League of Peace. Other founders of world movements who were given the Nobel Peace Prize include Cremer, founder of the Inter-Parliamentary Conference and of what became later the International Arbitration League; Moneta, founder of an Italian peace body and an opponent of irredentism; Fried, founder of *Die Deutsche Friedensgesellschaft*; Bertha von Suttner, founder of the Austrian Peace Organization; Bajer and Arnoldson, who founded the Danish and Swedish Peace Leagues, respectively (Bajer was also largely instrumental in founding the *Bureau International Permanent de la Paix* at Berne, which was run afterwards by Ducommun and Gobat), Jane Addams, founder of the Women's Peace Party, and Emily Balch, of the Women's International League for Peace and Freedom.

Another support of peace lies in international law, and the Committee in this connexion has awarded the Prize to the *Institut de Droit International* and to some of the leaders who bore the brunt of its work—Renault, Beernaert and Asser—the last-named turning largely to private international law. La Fontaine, another international jurist, actively opposed aerial warfare, while d'Estournelles worked as a politician for the *Entente Cordiale*.

Mediation and arbitration brought into view two statesmen of the United States, Theodore Roosevelt and Elihu Root. The First World War brought an award in 1917 to the *Comité International de la Croix Rouge* and in 1919 to Woodrow Wilson as founder of the League of Nations; work at and for the League of Nations was recognized in the cases of Léon Bourgeois, Branting and Lange, while Nansen's work for returning prisoners of war and refugees from Russia drew a well-deserved reward. His International Office for Refugees received a second prize just before the outbreak of the Second World War.

Politicians, for their share in easing international tension, form another group of prize-winners: Dawes of the Dawes Plan, Kellogg of the Kellogg Pact, and Nicholas Murray Butler of the Carnegie Endowment from the United States, Austen Chamberlain from Great Britain, Briand and Stresemann (who quite suitably divided the Prize), Buisson and Quidde, each pair representing France and Germany.

The churches are surprisingly little represented in the awards, Archbishop Söderblom and John Mott being the only individuals singled out, while the Society of Friends is the only religious body. No one could deny the propriety of the award in their case.

With the war clouds gathering again in the 30's, the Committee turned to people representing the work for collective security and resistance to aggression. Norman Angell, Arthur Henderson and Lord Cecil of the Peace Ballot represent this phase, also Saavedra Lamas for his work as mediator between Bolivia and Paraguay. The case of Ossietzky is left for later discussion. The Second World War brought a second award to the *Comité International de la Croix Rouge*, an award to the British and Americans' Friends Service Councils, a recognition of the important services of Cordell Hull in laying the foundations of the United Nations Organization, the hope for future world peace, and of Lord Boyd-Orr for his contribution to the peace of the world—increased food production.

At the end of 1936 the Peace Prize Committee awarded the Prize for 1935 to Carl von Ossietzky, the German pacifist. At the time he was in a German concentration camp, and it was clear that the award was a clear-cut demonstration against the Nazi régime. The Norwegian foreign minister and a former foreign minister and prime minister had resigned from the Prize Committee in advance to avoid political complications, and later the Norwegian Storting resolved that members of the Nobel Committee upon becoming members of the Government must withdraw from the Committee. Ossietzky died in prison in 1938 without receiving any aid from the award. Hitler was violently resentful and issued a decree forbidding German nationals in future to accept any Nobel Prize. But his ban could not prevent the Swedish committees from awarding prizes to Germans if they so wished, and actually the Chemistry Committee did award prizes to Kuhn and Butenandt and the Physiology Committee to Domagk. Domagk was arrested by the Gestapo and compelled to sign a letter declining the Prize; similar letters were sent by Kuhn and Butenandt.

The money thus refused by the recipients of the awards passed to the corresponding institutes set up under the statutes of the Nobel Foundation. These were established to assist in the scrutiny necessary for adjudication of the prizes and for the promotion of the purposes of the Foundation. They include the Nobel Library, whose collection of modern *belles-lettres* is now in a class by itself, at least in Europe; the Nobel Medical Institute, founded in co-operation with the Swedish Government, with departments of biochemistry, cytology and neurophysiology; the Nobel Institute, with a department of experimental physics in which a number of foreign students are carrying out researches; a department of chemistry is to be added before long. To complete the picture given by the statutes it only remains to describe the Norwegian Nobel Institute: its task is to guide the Committee in the award of the Peace Prize; it is a peace centre following the development of international relations and the work for their peaceful adjustment. It is associated with scholarly activities and also popular educational work for peaceful intercourse, justice and fellowship between nations.

Lastly, a few words about the statistics of the awards. Germany has provided the highest number of prize-winners, with the United States and the British Isles close behind. The United States have the highest number in medicine and peace, France in literature, Germany in chemistry and Great Britain in physics. The only case where one country has a substantial lead is Germany in the field of chemistry. The fact that Germany was ruled out for some years after 1939 makes comparison for different groups of years difficult; but looking through the lists one cannot but see the growing importance of the United States in later years. It is clear that the centre of first-class scientific research has shifted from Europe to the United States. This may be in part due to the greater resources available there, in part to the number of distinguished men of science who have settled there, in many cases as refugees, in part also to the exhaustion of European countries by two world wars; but the reason for the change lies principally in the Americans themselves. They have had the opportunities; but they have also found the men to make use of them. While the performance of Great Britain, as revealed by the Nobel awards, has kept at a steady high level, that of the main European countries has very sadly fallen away, while that of the United States has risen remarkably. The United States stand to-day in the world of science where Germany stood fifty years ago.

Finally, a word of tribute must be paid to those who have written this book. They have all been active in the work of the Nobel Foundation in one capacity or another. They would all probably have echoed the words of Ragnar Sohlman, by whose death in 1948 the last link with the founder was lost, "I feel it an unforgettable experience to have taken part in the organisation of the Nobel Foundation". This he had done from the very first. It has been a great task that the various electing bodies have carried out. Entering upon it in many cases with misgiving and reluctance, they have so discharged their duties that Scandinavian honesty and impartiality have become widely recognized, and a general knowledge of and respect for northern civilization have spread over the whole world. Alfred Nobel's ideas and ideals have proudly and successfully come alive under the wise guidance of those to whom he entrusted his great scheme.

F. J. M. STRATTON

PHYSICS OF RUBBER-LIKE MATERIALS*

By DR. L. R. G. TRELOAR

British Rayon Research Association, and the Davy Faraday Research Laboratory, Royal Institution

Basis of Rubber Elasticity

TO account for the large elastic deformability of rubber-like materials, it is necessary to find a molecular mechanism involving comparatively long-range forces. The elasticity of ordinary solids may be satisfactorily explained in terms of the electrical fields of force between atoms, but, since these fields fall off rapidly with distance, such a mechanism cannot be expected to apply if the displacements of the relative positions of atoms are large. An approach based on concepts other than that of static intermolecular force fields must therefore be envisaged if, as is the case with rubber, deformations of the order of 500 per cent or more are involved.

In the development of theories of rubber, therefore, it is not surprising that we find a number of references to a loosely coiled or open network structure, composed either of long-chain molecules or of molecular bundles or micelles. In one form of this theory[1], the network was imagined to form a 'gel skeleton' of high-molecular material, which provided the essential elasticity of the rubber, the space between the meshes being filled out with a low-molecular component of a viscous nature. This theory derived some support from the well-known fact that rubber may be divided by suitable solvents into two fractions, a soluble or 'sol' fraction of between 50 and 90 per cent, and a residual insoluble or 'gel' fraction. Later researches, however, have shown that this distinction is less fundamental than was at first thought, and that 'sol' rubber, if separated with exclusion of oxygen, possesses all the essential elastic properties of total rubber.

* Synopsis of four lectures given at the Royal Institution on November 2, 9, 16 and 23.

A considerable clarification of ideas was brought about in 1932 by Busse[2], who discussed in detail the conditions which had to be fulfilled by rubber-like materials, on the basis of the molecular network model. Busse avoided the necessity for different molecular species by introducing two different types of force. He considered the rubber to be built up of chain-like molecules of great length, the primary valence bonds in the chain being sufficiently strong to resist the stress applied during deformation. Between these long-chain molecules he postulated relatively weak secondary (van der Waals) interactions, which would not prevent movement of the chains relatively to one another. To prevent bulk slippage or flow by relative movement of the molecules, Busse further postulated the necessity for the introduction of a certain number of cross-linkages, or primary-bond connexions between the long-chain molecules, which, though not greatly impeding local movements of the chains, would be sufficient to link up the system into a single three-dimensional network. (Technically, the process of cross-linking is known as vulcanization, and, as its name implies, is usually effected by sulphur or sulphur-containing compounds.)

Busse's conception has survived in all essentials to the present time; but his scheme contains one serious omission—it suggests no mechanism for the elasticity of the individual molecular chain.

The solution to this problem—the key problem in rubber elasticity—was to follow in a very short time. With the increased study of high polymers, both natural and synthetic, and the development of more accurate methods of investigating their molecular weights, it was becoming clear that the molecular weights of rubbers were probably in the region of 100,000–1,000,000, which is much larger than had been suggested by earlier work. With this knowledge, new concepts began to emerge with regard to the nature of these molecules. Attention was given to their *physical* as distinct from their chemical characteristics, in respect of which all long-chain molecules possess features in common. It began to be realized that such molecules, comprising perhaps twenty thousand carbon atoms in a single chain, would be very unlikely to act as a rigid unit, but would be subjected to varying degrees of local deformation on account of the mechanical impacts or thermal bombardment of neighbouring molecules. Hence arose the kinetic or statistical theory of elasticity, in which this thermal fluctuation was given the central role.

The statistical theory, first explicitly proposed by Meyer and his associates[3] in 1932, and developed mathematically by Kuhn[4] and by Guth and Mark[5], postulates relative freedom of rotation about each of the single bonds of the molecular chain, by virtue of which the molecule takes up a variety of statistically determined configurations. In such a randomly kinked chain the number of available configurations is a function of the distance between its ends, becoming greater as this distance is reduced. Assuming that all configurations have the same *a priori* probability, it is found, in consequence, that the molecule will tend to take up a contracted or randomly kinked form rather than the extended or linear form. By relating the entropy to the configurational probability, it is easy to show that the entropy must decrease as the ends of the molecule are separated, and that, in consequence, a force is necessary in order to hold the molecule in the extended configuration. The molecule is thus inherently elastic.

Thermodynamic Consequences of Kinetic Theory

This kinetic or statistical theory of elasticity leads at once to two important results, namely: the extension of rubber gives rise to an *evolution* of heat; and the elastic tension in rubber stretched to a constant length increases with rising temperature.

These two effects have their analogues in the kinetic theory of gases, in which a compression gives rise to heating, while the *pressure* at constant volume is proportional to temperature. The analogy goes deeper, for in both cases we are dealing with a system in which the internal energy (at constant temperature) is unaffected by the deformation, while the force exerted arises from a change of configurational entropy. Both the effects have been known for a long time, and have been studied by Gough (1805) and by Joule (1859).

The Molecular Network

It is doubtful whether the kinetic theory would have come to occupy so prominent a place in the scheme of high-polymer physics had it not been for the development, during the past few years, of exact mathematical relations representing the mechanical and other physical properties of rubber in terms of the statistical properties of a network of long-chain molecules. This development has been of outstanding importance, not only in providing us with a powerful method of verifying the theory, but also in suggesting new methods of studying and representing the physical behaviour of rubbers which are both simpler and more complete than earlier methods. This will be illustrated by the following examples.

The fact that rubber can be deformed in a variety of ways is familiar to most people: it can be subjected to extension, compression, shear, torsion, etc. From the engineering point of view, it is of importance to know how to describe its behaviour under any type of strain. The classical theory of elasticity is of little help, since it is in principle restricted to strains which are both small and proportional to the applied stress. In rubber, neither of these assumptions is applicable. A completely new approach is therefore essential.

The problem has been very neatly solved by the statistical theory of the molecular network. For the case of a simple elongation, the relation between the force, F, per unit area of the unstrained cross-section, and the extension *ratio* α is[6]

$$F = NkT(\alpha - 1/\alpha^2), \qquad (1)$$

where N is the number of chains, or molecular segments between junction points of the network, k is Boltzmann's constant, and T the absolute temperature. The same formula is valid for a compression in one direction ($\alpha < 1$). It is seen that the force–extension relation is non-linear, in agreement with experiment. For simple shear, on the other hand, the relation between shear stress t and shear strain σ is linear, and is given by the equation[6]

$$t = NkT\sigma. \qquad (2)$$

This conclusion, that rubber should obey Hooke's law in shear, but not in elongation or compression, explained what had long been known from observation, and was a striking initial success for the network theory. Another important conclusion, also borne out by experiment, is that the modulus of elasticity is determined only by the *number* of chains forming the network, that is to say, by the number of cross-links introduced during vulcanization.

The equations (1) and (2) are particular forms of a more general relation between the principal stresses and principal strains, which may be derived for the case of a pure homogeneous strain of the most general type[7] characterized by the deformation of a sphere into an ellipsoid having three unequal axes. It is found again that this more general formula involves only one molecular parameter. We thus arrive at the important conclusion that all the elastic properties of a vulcanized rubber may be described by means of a single molecular parameter, which is related to the degree of cross-linking, but is independent of its precise chemical constitution.

Space does not permit the discussion of recent experimental investigations[8,9] by which these theoretical deductions have been subjected to a thorough examination. The present position may be summarized by saying that, while the statistical theory has been substantiated in all its principal aspects, as a first approximation, there are important departures in detail which have not yet received any satisfactory explanation, and which may well repay further examination.

[1] Ostwald, *Kolloidzschr.*, **40**, 58 (1926).
[2] Busse, *J. Phys. Chem.*, **36**, 2862 (1932).
[3] Meyer, v. Susich and Valko, *Kolloidzschr.*, **59**, 208 (1932).
[4] Kuhn, *Kolloidzschr.*, **68**, 2 (1934); **76**, 258 (1936).
[5] Guth and Mark, *Mh. Chem.*, **65**, 93 (1934).
[6] Wall, *J. Chem. Phys.*, **10**, 485 (1942).
[7] Treloar, *Trans. Farad. Soc.*, **39**, 241 (1943).
[8] Treloar, *Proc. Phys. Soc.*, **60**, 135 (1948).
[9] Rivlin and Saunders, *Phil. Trans.* (in the press).

OBITUARY

Prof. T. Turner

With the death on January 31 in his ninetieth year, at his home at Leatherhead, of Thomas Turner, emeritus professor of metallurgy in the University of Birmingham, one of the remaining links of the University with Mason College has been broken. While studying at the Birmingham and Midland Institute, Turner won a studentship at the Royal School of Mines, South Kensington, in 1878. Later he returned to Birmingham as a demonstrator in chemistry under Tilden in Mason College. In 1902 he became professor of metallurgy, a post which he held until his retirement in 1926 under the age limit.

Prof. Turner's metallurgical work was varied, and his name was prominent for many years in connexion with the application of science to the production and handling of metals. He was particularly well known for his early researches on the influence of silicon on the properties of cast iron, on which subject he presented a series of papers between 1883 and 1888 to the Chemical Society, the British Association and the *Journal of the Iron and Steel Institute*. This pioneer work, followed, as it was, by studies of the effects of other elements on the properties and structure of cast iron, laid the foundation of scientific iron founding and met with wide application.

A gap in his published work corresponded with his appointment as director of technical instruction to the Staffordshire County Council, but during 1902–26, when he held the chair of metallurgy at Birmingham, his name constantly appeared as the author of papers in the scientific and technical journals. While he never lost his early interest in the iron foundry, his work as professor covered a wider field.

With the formation of the Institute of Metals in 1908, in the foundation of which Prof. Turner played a prominent part, papers dealing largely with the behaviour of metals on solidification appeared in the *Journal* of that Institute at least as frequently as in the *Journal of the Iron and Steel Institute*.

The Institute of Metals recognized his pre-eminence by inviting him in 1921 to give its May Lecture, and, in 1924, electing him to the office of president. The Iron and Steel Institute's award of the Bessemer Gold Medal in 1925, the Fox Gold Medal of the Institute of British Foundrymen and the Seaman Gold Medal of the American Foundrymen's Association completed the acknowledgment of Prof. Turner's stature in his profession.

In spite of this formidable record of achievement in metallurgical work, those who had the privilege of studying under Prof. Turner will think of him first as a man of great personal charm and kindliness. The respect in which he was held as an individual was well shown by the number of committees, councils and similar bodies on which he served throughout his life.

The fact that he was fortunate enough to remain active in such work until only a few years ago, and preserved for a long time a comparatively youthful physical and mental outlook, makes one the more surprised to realize that much of his first-class metallurgical work was done nearly seventy years ago. He is survived by his widow, two sons and two daughters.

G. L. Bailey

NEWS and VIEWS

University College, London : Dr. D. R. Pye, C.B., F.R.S.

Dr. D. R. Pye retires from his post as provost of University College, London, at the end of the present academic year. He has held that office since 1943, when he was appointed to succeed the late Sir Allen Mawer, and during the intervening years his achievements in conditions of almost unparalleled difficulty have been remarkable. University College suffered devastating losses by damage during the War, and it fell to Dr. Pye to tackle the task of rehabilitation while providing by temporary measures for a very great influx of students following the end of hostilities. Although permanent buildings are only now beginning to take shape, staff and students alike have good reason to be grateful to Dr. Pye for the energy with which he applied himself to the solution of the almost overwhelming problem which had to be faced in 1945. In much of this work Dr. Pye's previous experience was invaluable; but the measure of his success as provost would have been very different had he been less gifted in the understanding of personal as well as of material problems. Under his wise guidance many new fields of study have been developed, and the high position occupied by the College to-day in leading new thought on so many branches of learning is a tribute to his work. During his period of office Dr. Pye has given every ounce of his energy to the welfare of the College, and in spite of all the difficulties that confronted him he has made it a happy community. His natural inclination

must have tended to direct his attention towards scientific matters; but he has always given every department of the College without distinction an equal share of his time and interest. It must be recalled that, before going to University College, Dr. Pye had an equally distinguished career as director of scientific research at the Air Ministry. He held that responsible post during the most difficult years of the Second World War, and in leaving it he faced another great task at University College, a task from which he now retires, taking with him the gratitude, the affection and the good wishes of all. He is succeeded by Dr. B. Ifor Evans, at present principal of Queen Mary College, London.

Institute of Brewing: Award of Horace Brown Medal

Prof. Harry Lundin, vice-president of the European Brewery Convention, has been awarded the Horace Brown Medal of the Institute of Brewing. Prof. Lundin, of the Division of Food Chemistry, Royal Institute of Technology, Stockholm, is well known in brewing circles throughout the world and has carried out important researches on topics of interest not only to the brewing industry but also to other fermentation industries. His recent papers have been concerned with, among other topics, measurement of the bittering capacity of hops, the amylases of barley and malt, the significance of proteins in brewing, and the microbiological synthesis of fats. The Horace Brown Medal is awarded by the Institute of Brewing in memory of the late Horace Tabberer Brown, in recognition of eminent services on the scientific or technical sides of the fermentation industries. It was founded in 1925, and there have been six previous awards.

Royal Society of Edinburgh: New Fellows

The following have been elected to the Royal Society of Edinburgh: Prof. J. Allen, Department of Engineering, University of Aberdeen; Dr. D. S. Anderson, director of the Royal Technical College, Glasgow; Miss Evelyn V. Baxter, vice-president, British Ornithologists' Union; Prof. D. Campbell, Department of Materia Medica, University of Aberdeen; Dr. G. A. Cumming, Department of Geography, University of St. Andrews; Prof. Bhalchandra Babaji Dikshit, principal of B. J. Medical College, Poona; D. K. Duff, consulting civil engineer; Prof. S. C. Harland, Department of Botany, University of Manchester; Harry Hoggan, producer, British Broadcasting Corporation; P. Jackson, acting director, Scottish Seaweed Research Association; Dr. R. Y. Keers, medical director, Red Cross Sanatoria of Scotland; Prof. R. J. Kellar, Department of Obstetrics and Gynæcology, University of Edinburgh; J. T. Kendall, Leverhulme Research Fellow; Dr. H. W. Kosterlitz, Department of Physiology, University of Aberdeen; Dr. D. McCall, resident secretary in Scotland to the Pharmaceutical Society of Great Britain; I. McHardy, director of education for Caithness; Principal W. M. Mitchell, Royal (Dick) Veterinary College, Edinburgh; A. C. O'Dell, Department of Geography, University of Aberdeen; Miss Leonora J. Rintoul, joint-president, Scottish Ornithologists' Club; Prof. A. E. Ritchie, Department of Physiology, University of St. Andrews; Prof. P. D. Ritchie, Department of Technical Chemistry, Royal Technical College, Glasgow; Dr. Marion A. S. Ross, Department of Natural Philosophy, University of Edinburgh; Dr. J. M. Stagg, principal deputy director of the Meteorological Office, Air Ministry; Dr. R. A. Taylor, Department of Botany, University College, Dundee; and Prof. D. Whitteridge, Department of Physiology, University of Edinburgh.

Electrodepositors' Technical Society: Awards

The Gold Medal for 1951 of the Electrodepositors' Technical Society, the highest honour that the Society can bestow, has been awarded to Dr. S. Wernick, past president of the Society and honorary secretary and chairman of its Publications Committee. Dr. Wernick, who is a consultant to several leading industrial concerns, has published a number of papers on the electrodeposition of metals and is author of "Electrolytic Polishing and Bright Plating of Metals". Honorary membership of the Society has been conferred on Dr. William Blum, who for many years has been associated with the National Bureau of Standards, Washington, D.C. Dr. Blum's researches into electrodeposition have contributed greatly to progress in this field, and he is the co-author, with Mr. G. B. Hogaboom, of "Electroplating and Electroforming", which for twenty years has been a standard work on electrodeposition practice and has recently been issued in a revised form.

Permanent Endowment of the Cambridge Chair of Electrical Engineering

The endowment of a chair of electrical engineering in the University of Cambridge was foremost among the University's post-war requirements formulated in 1944. So that there should be no delay in executing the plan as quickly as possible after the end of the War, the Institution of Electrical Engineers offered to provide such a chair for a period of five years pending the completion of arrangements for a permanent endowment. The offer was accepted by the University, and in 1945 Prof. E. B. Moullin was appointed as professor of electrical engineering. There can be little doubt that the electrical profession and industry of Great Britain have greatly benefited from this generous action. In recognition of this, the British Electrical and Allied Manufacturers' Association undertook that, at the end of the five-year period, it would raise money for the endowment of the chair in perpetuity. The sum of £71,000 was subscribed by 152 member-firms of the Association, and was formally accepted by the University at a recent luncheon given at Pembroke College, Cambridge.

Research in the British Steel-Foundry Industry

An agreement has recently been reached between the British Iron and Steel Research Association and the Research and Development Division of the British Steel Founders' Association whereby the latter becomes responsible for the co-operative research requirements of the steel-foundry industry. Certain facilities and funds in connexion with the work which has been initiated by the British Iron and Steel Research Association in the field of steel castings has been handed over to the Research and Development Division of the British Steel Founders' Association. This Division was formed a little more than twelve months ago, with Mr. J. F. B. Jackson as director. The transfer of responsibility, as a whole, is indicative of the close liaison that exists between the two Associations on matters of common interest.

Reindeer in Scotland

In a written reply in the House of Commons on March 8, the Secretary of State for Scotland said: "I have informed the Reindeer Council of the United Kingdom through the Scottish Council (Development and Industry) that the Government are prepared, as an exceptional arrangement in view of the possible advantage to the Scottish economy, to authorize the import of 25 reindeer from Sweden so that an experiment to determine whether they can be usefully and successfully reared on a suitable site in the Highlands and islands may be carried out. The experiment would be subject to strict conditions which have been suggested by the Nature Conservancy and to animal health safeguards". On the previous evening an exhibition of reindeer products was opened at 14 Ladbroke Square, London, W.11, by Sir Frederick Whyte, chairman of the Reindeer Council.

Astronomy in Ireland

The issue of the *Irish Astronomical Journal* for September 1950 (1, No. 3), like those that have preceded it, contains a number of interesting articles, the most important of which is Dr. E. J. Öpik's contribution, "Interstellar Meteors and Related Problems". Dr. Öpik is convinced that many meteors have hyperbolic velocities and hence arrive in the solar system from interstellar space. He devotes seventeen pages to an analysis of the observational results and gives a brief description of the rocking mirror which he devised at Harvard College Observatory to determine the velocities of meteors. Convinced that Porter's analysis of the hyperbolic velocities obtained during the Harvard College Expedition to Arizona to study meteors in general is open to serious objections, he quotes Dr. A. C. B. Lovell, whose work at Jodrell Bank, University of Manchester, on meteors, by utilizing radar, is well known. Two years ago, Dr. Lovell admitted that many hyperbolic velocities had been measured. (In an article in *Discovery* of January 1951, Dr. Lovell states that at present the radio measurements strengthen the case of those who believe that all meteors are members of the solar system.) In addition to a number of topics included under "News and Comments", Dr. M. Davidson has an article entitled "The Atmospheres of the Earth and Planets", which is a summary of a recent book by eighteen authors, edited by Prof. Gerald P. Kuiper (University of Chicago Press, and Cambridge University Press, 1949). Very important work was carried out over a period of some years by means of rockets capable of rising to heights of a hundred miles or more and dropping meteorological instruments during their descent. Richard Hayward (a well-known author on Irish life and scenery), in collaboration with John H. McElderry, has an article with the title "Astronomy Sixty Years Ago; The Ulster Astronomical Society 1890/94", which provides an excellent account of a Society that set out with high hopes and came to an untimely end. Judging by the interest in astronomy in Ireland at present, one can safely predict that there is no danger of the Irish Astronomical Society meeting with a similar fate.

St. Ives Research Station of the Board of Greenkeeping Research

The St. Ives Research Station at Bingley, Yorks, of the Board of Greenkeeping Research reports that in 1950 another year of successful progress was made. The total number of advisory visits carried out was 1,135, as compared with 942 in 1949 and 752 in 1948. Extended advisory tours were made in Great Britain and the Republic of Ireland, and visits were also paid to Sweden, Belgium, Holland and Switzerland. The figures for the correspondence of the Station show that in 1950 a total of 18,436 letters was dispatched (as against 14,821 in 1949, and 10,243 in 1948), 11,306 being in answer to technical inquiries from affiliated clubs and organizations. On the educational side, a number of courses of instruction were arranged, and lectures and advisory talks continued to play a prominent part in the Station's outside activities. In September, a series of functions were held at the Station to mark its twenty-first anniversary (see *Nature*, September 16, 1950, p. 463). Pressure of work in the laboratory has increased very rapidly since the end of the Second World War, 5,711 samples being analysed last year as compared with 4,492 in 1949; it was necessary, therefore, to take over another building adjoining the office block and convert it into a new laboratory. The increase in the activities also necessitated the appointment in August of two more advisory officers: Mr. G. R. Lewis, a graduate in agricultural botany of the University College of Wales, and Mr. J. D. Joss, who holds the diploma of horticulture of the University of Edinburgh and who for some time past has held a post in the Royal Botanic Gardens, Edinburgh.

Colonial Plant and Animal Products

The main article in a recent issue of the journal of the Colonial Products Advisory Bureau (*Plant and Animal*, 1, No. 2; 1950. H.M. Stationery Office) has been compiled by members of the staff of the Inter-departmental Committees of the Agricultural Research Council and of the Bureau and deals with natural and synthetic organic insecticides. Other articles deal with essential oils from Tanganyika; cinnamon bark from Seychelles; marama oil from Bechuanaland; tobacco from Mauritius; leaves and bark from Nigeria; tonka beans from Nigeria; aloes from the Leeward Islands; tingo fibre from Nyasaland; ginger from Sierra Leone; grain-cracks in hides; and the drying of goat skins. Notes are also given on bamboo cultivation and utilization; the determination of pyrethrins in *Pyrethrum* flowers; the market in the United Kingdom for Colonial pig skins; and rice cultivation in the U.S.S.R. The journal also includes the usual book reviews and lists of recent books in agriculture and forestry.

Production Control in the Small Factory

The *BS* 1,100 series—"Office Aids to the Factory"—was originally written for the British Standards Institution during the War to help firms engaged on armament production, particularly those entering this field for the first time. One of the series has now been revised by the British Institute of Management and published under the title of "Production Control in the Small Factory". The original books were written primarily in terms of the engineering industry; but most of the information can be applied to any factory engaged on small- and medium-size batch production of fairly simple articles, whatever the industry. The extensive use of tabulation should make the booklet of value as a work of reference, especially for managers of factories employing fifty to two hundred people. The main revisions have been the elimination of sections on cost comparison

and the labour analysis schedule and the inclusion of a diagram showing the organization of a small works. Copies can be obtained from the British Institute of Management, 8 Hill Street, London, W.1, price 2*s.* 6*d.*, including postage. The Institute is also preparing a similar publication for more general application.

Royal Society Lectures for 1951

The subject, speaker and date of the Royal Society Lectures for 1951 have been announced as follows: *Croonian Lecture*, "Lethal Synthesis", by Prof. R. A. Peters, Whitley professor of biochemistry, Oxford, on June 7; *Bakerian Lecture*, "Reactions in Monolayers", by Prof. E. K. Rideal, professor of chemistry, King's College, London, on June 21; *Leeuwenhoek Lecture*, "The Place of Viruses in Nature", by Dr. C. H. Andrewes, National Institute for Medical Research, Mill Hill, on December 13.

Association of Applied Biologists: Officers for 1951

The following are the officers for 1951 of the Association of Applied Biologists: *President*, R. W. Marsh; *Vice-Presidents*, Dr. J. W. Evans and Dr. H. C. Gough; *Honorary Treasurer*, Dr. H. F. Barnes; *Honorary General Secretary*, Dr. R. K. S. Wood (Imperial College, London, S.W.7); *Honorary Programme Secretary*, Dr. L. Broadbent (Rothamsted Experimental Station, Harpenden, Herts); *Honorary Editor of the Annals of Applied Biology*, R. W. Marsh; *Honorary Assistant Editor*, Dr. I. Thomas.

University of London

The following announcements have recently been made by the University of London. D. R. Bates and Dr. R. A. Buckingham have been appointed to University readerships in physics, tenable at University College. The title of reader in aeronautical engineering in the University has been conferred on Dr. L. G. Whitehead, in respect of the post held by him at Queen Mary College. The degree of D.Sc. has been conferred on E. Lewis-Faning and E. A. R. Braude.

Evaluation of Chemotherapeutic Substances

The Biological Methods Group of the Society of Public Analysts and Other Analytical Chemists is arranging an open symposium on the evaluation of chemotherapeutic substances, to be held in London during October 26–27, with Dr. G. W. M. Findlay in the chair. Papers will be presented dealing with the assay of anti-bacterial, anti-protozoal and similar substances by both *in vivo* and *in vitro* methods. Intending contributors should write to the honorary secretary, S. A. Price, at Walton Oaks, Dorking Road, Tadworth, Surrey.

Announcements

The Lord President of the Council has appointed Dr. D. D. Pratt, acting director of the Chemical Research Laboratory, Teddington, to be director of the Laboratory. Sir Robert Robinson has accepted the invitation of the Lord President to act as an honorary consultant to the Laboratory on research in pure organic chemistry.

The Aluminium Development Association is offering a research scholarship, of value £400 a year and tenable for two years, for the encouragement of research into the application of light alloys to ship construction. Further particulars of entry, which closes on June 30, can be obtained from the Secretary, Institution of Naval Architects, 10 Upper Belgrave Street, London, S.W.1.

The Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland are offering, for the academic year beginning October 1 or earlier, a limited number of postgraduate scholarships in agricultural economics, husbandry, statistics and agricultural and dairy engineering. Further particulars and application forms (to be completed by May 1) can be obtained from the Secretary, Ministry of Agriculture and Fisheries (Research Branch), 1–4 Cambridge Terrace, Regent's Park, London, N.W.1, or the Secretary, Department of Agriculture for Scotland, St. Andrew's House, Edinburgh, 1.

In order to induce younger scientific workers to take an interest in the work of the British Association for the Advancement of Science and to raise the literary standard of scientific writing, Imperial Chemical Industries, Ltd., publisher of *Endeavour*, is again offering four prizes totalling 90 guineas to be awarded for an essay, not exceeding four thousand words, on a given scientific subject. Competitors must be less than twenty-five years old and must send in their essays before June 1. Further details of these prizes, which are to be known as *Endeavour* prizes, can be obtained from the Assistant Secretary, British Association for the Advancement of Science, Burlington House, Piccadilly, London, W.1.

The summer meetings of the Royal Astronomical Society will be held at the University College of the South West, Exeter, during July 24–26. In addition to the usual proceedings, a popular lecture, a geophysical discussion and an excursion to the Norman Lockyer Observatory at Sidmouth will be arranged. Further details can be obtained from the assistant secretary of the Royal Astronomical Society, Burlington House, London, W.1.

The ninety-sixth annual exhibition of the Royal Photographic Society will be held at 16 Princes Gate, London, S.W.7, during September 14–October 14, and afterwards in Scotland. All aspects of photography (including narrow-gauge kinematography) will be exhibited. The closing date for entries, from members and non-members alike, is July 31, and details can be obtained from the secretary at the above address.

The Textile Institute will hold its annual general meeting at the Midland Hotel, Manchester, on April 18. The meeting will be followed by the Mather Lecture, which this year is to be given by Dr. J. C. Withers, a vice-president of the Textile Institute and former head of the Library and Information Service of the British Cotton Industry Research Association, who will speak about information on textiles. The Mather Lecture, which is an annual event, was inaugurated in 1919 to perpetuate the memory of the late Sir William Mather, president of the Institute during 1915–17 and promoter of the Institute's Foundation Fund in 1919.

Erratum. In the communication "Influence of Folic Acid on Xanthine Oxidation *in vitro*" by Miss P. Fatterpaker and Dr. A. Sreenivasan in *Nature* of January 27, p. 149, par. 2, line 13, for "1·5 gm." read "1·5 μgm.".

SCIENTIFIC METHOD IN INDUSTRY

A CONFERENCE of the Royal Statistical Society, held at the University of Sheffield during September 29–October 1, 1950, was arranged by the Industrial Applications Section. This Section is made up of local groups which meet at six centres in England and Wales, and it is only on such occasions as this that its strength becomes evident.

The title of the conference, "Scientific Method in Industry", was purposely made broad in order to attract to the meetings many who might be misled by any title including the word 'statistics' into thinking it too specialized for them. It is, in fact, true that statistical method, in providing a numerical basis for scientific method, has almost become that method itself; one certainly cannot fully make use of the tools provided by the science of statistics without coming up against the fundamentals of scientific method. The list of the titles read and discussed amply justifies the broad title.

In opening the conference on the afternoon of September 29, the president of the Society, Prof. A. Bradford Hill, recalled a conference at Oxford two years ago at which the opportunities for informal discussion were so much appreciated. He hoped that the present conference would be fruitful in the same way and, being open not only to the Fellows of the Society but also to others who had cared to apply, might lead to a wider understanding of what statisticians have to offer to industry.

The first session, under the chairmanship of L. H. C. Tippett (Shirley Institute), who has himself been responsible for a great deal of statistical work in the cotton industry, consisted of descriptions by representatives of three leading industries of the contributions made by statistics to their own problems of production and scientific management. Mr. Tippett, in his opening remarks, pointed out the way statistical method, with its powers of handling masses of figures, and its ability to take account of chance variation, can contribute to industry and to management. The functions of management are first to set up an organization for producing something and then to run it. The first of these functions continues the technology of the process and includes the whole process of fitting man and machine. The problem of specification, one which essentially must take account of variation, also enters into this function. The problem of running the organization thus set up includes some sort of anticipatory control, as well as anticipatory maintenance. Inspection schemes, productivity measurement, labour utilization and quality control, these are all problems involving the study of variability and are thus susceptible to statistical method.

All three speakers of the afternoon session, T. W. G. Boxall (London Brick Co.), A. Ellis (Booth and Colclough) and B. Moorhouse (Rowntrees), testified to the enlightenment which has followed the use of statistical method in studying their production problems. The first has been able to get better control of dimensions and water content of the material for making bricks; the second, which is a pottery firm, has discovered relationships between successive stages of their processes, while Rowntrees has solved two problems involving weight specification of a product.

At the evening session of the opening day, Philip Lyle (Tate and Lyle, Ltd.) described the way he has applied statistical methods to the determination of marginal costs. In a firm with a number of factories, each tuned to work at a certain output-level, it is important for management to know the effects on costs of fluctuation in that output, since there is scope for adjustment of load between the factories, according to their marginal costs. Controlled experiments are possible under certain limited conditions. Dr. B. P. Dudding, who had advised on much of the work described earlier in the afternoon, summed up the day's proceedings and gave some further examples from his own experience to illustrate the points he made.

The programme for the second day included papers from three visitors from abroad. Dr. W. J. Youden, assistant chief of the Statistical Engineering Laboratory, United States National Bureau of Standards, read a paper on "Improving the Precision of Measurements". In it he gave an interesting account of an experiment on the testing of clinical thermometers, which he used to illustrate the need to recognize and measure the appropriate error when estimating the magnitude of a suspected effect, and his example showed that some very misleading conclusions can be arrived at if this is not done. Dr. H. S. Hamaker (of Philips Electrical (Eindhoven)) and C. Enters (Van der Heim) gave a paper on "Multiple Sampling, in Theory and Practice", which was remarkable for its clear and complete presentation of a particular aspect of the sequential sampling process (successive samples all of the same size, total number limited) and for its enunciation of principles of choice of scheme. The authors overcome the difficulty involved in characterizing a scheme by its performance over the whole possible range of quality by using only the slope of the characteristic at the point where the frequency of acceptance is 0·5. This, although arbitrary, has the advantage of expressing the usual two parameters of a characteristic in one. A further simplification is their use of the "equivalent single sampling scheme" as a standard of comparison for the average sample size of a sequential scheme.

F. J. Anscombe (University of Cambridge) presented an interesting survey of developments in industrial inspection methods, under the title of "The Cost of Inspection". The subject of cost has not, perhaps, received the attention it needs, since it is possible that many are deterred from adopting sampling schemes by the absence of factual information about the economic advantage over their present methods. It is significant of the lead which theory has over practice in this subject that the author had to confine himself to outlining the type of investigation needed to obtain these costs rather than give actual figures. It is to be hoped that one result of the conference will be that actual users will publish the results of their investigations.

In a short paper, B. H. P. Rivett (Ministry of Supply) described a sequential method of analysing machine performance which should be useful especially in the initial stages of setting up a process or a new machine, because of the measured assurance it gives that the setting is correct and the economy of time and effort.

A paper by Prof. G. A. Barnard (Imperial College of Science and Technology, London) entitled "Selective Assembly Processes" equally deserves the attention of manufacturers in many fields other than the radio

industry which Prof. Barnard used to illustrate his points. Problems of design, of economy, of production and of specification all come within the ambit of this subject. It is sometimes argued by theoreticians that, in assembly, tolerances of assembled units should not be taken as simply additive, since the extremes rarely fall to be assembled together. Prof. Barnard's industrial experience, however, leads him to believe that, under certain conditions of production which not infrequently occur, such a result may, in fact, be approximately true. His point is that an investigation into the process curve (the frequency distribution of what is actually being produced) will provide the information needed to decide whether random assembly can satisfy the tolerances demanded in a particular case. He also dealt with the choice of number of classes, the importance of long runs, and the advantages of multiple selective assembly (choice of classes to be assembled) where tolerances permit.

D. J. Desmond (University of Birmingham) brought new light to bear on the craft of time-study in his paper "The Statistical Approach to Time-Study". This was based on an earlier paper to Section G of the British Association for the Advancement of Science which has been fully reported in *Engineering*. It is a matter of opinion whether it is necessary, as he has done, to pander to the existing nomenclature to the extent of using a term 'reciprate' for the reciprocal of the rate, but it cannot be denied that the clear light of statistical method will do much to remove the causes of the criticism that has been directed at the science of work-study.

Also in the programme for September 30 was an account by Dr. H. Ingram (Wool Research Association) of productivity measurement in the United States. Dr. Ingram had been a member of the West European team which had worked at the Bureau of Labour Statistics. His remarks aroused great interest, which seemed to belie his general theme concerning the relative interest aroused by the subject in the two countries. His matter-of-fact conclusion was that there are two immediate tasks which, if undertaken, might yield much fruit and prove more profitable than much current argument as to the meaning of productivity. These two tasks are, first, the collection of data on overall output and labour, and second, detailed comparison among firms of various important aspects of a business, such as labour turnover and costing. Even though no theoretical standards were developed, the mere knowledge of these comparisons would lead to the eradication of much inefficiency.

On October 1 Dr. E. A. G. Knowles (University of Birmingham) and Miss C. Roseman (British Nylon Spinners) gave an interesting account of methods they have used for presenting the results of an analysis of variance to those concerned with production. It is rare to find, as here, a well-designed experiment carried out under production conditions. The difficulties usually appear insuperable to the production side, but these newcomers to British industries seem to have found the way. It was the special purpose of the paper to show how the various causes of variability can be exhibited in a manner analogous to the usual control chart; it was equally valuable in showing that, with planning, such experiments on plant actually in production can not only be carried out but also understood by all concerned.

E. D. van Rest (National Physical Laboratory) brought to his audience some little-known results on the problem of deciding how many operators should attend a bank of machines. The drive for redeployment of labour has brought this problem very much to the fore in the past few years. While solutions are available for the corresponding problem of telephone traffic, these are not directly applicable to the problem of one 'piecer' looking after many spindles. If one worker is given too many to look after, some will stay idle, while if too few, his time is not fully occupied. The problem is by no means limited to this field. Mr. Rest directed attention to the ubiquity of the problem and to the methods of solution available, including analogue machines and punched-card methods. For the particular case of a few machines (up to twenty) he was able to present a series of graphs based on the work of D. Westgarth (University College, London, and Institute of Rubber Research, Kuala Lumpur).

The last afternoon of the conference was devoted to a discussion on the proposed Industrial Section of the International Institute of Statistics and to channels of publication for such papers as the conference had evoked. G. H. Jowett, as secretary of the Sheffield Group and chairman of the Organizing Committee, wound up the conference, paying tribute to the University of Sheffield, which had been most generous in the provision of facilities for the whole conference.

The Society intends to publish in book form a collection of the papers presented. The conference was of undoubted value in bringing together a number of people with similar interests. The interest displayed is thought to be enough to justify a journal of applied statistics, of which the industrial applications would form a strong feature. Such a journal would be welcomed in many quarters.

E. D. van Rest

CALCULATING MACHINES AND HUMAN THOUGHT

A COLLOQUIUM on "Les Machines à Calculer et la Pensée humaine", organized by a committee of the Centre National de la Recherche scientifique under Prof. J. Peres and Prof. L. Couffignal, was held at the Institut Blaise-Pascal, Paris, during January 8–13. As the title of the colloquium indicates, its intention was to bring about an exchange of ideas between those concerned with the mechanical imitation of certain aspects of human thought and those studying the nervous system through which human thought is mediated. It can be said at once that, in so far as the number and distinction of the company which gathered in Paris are any indication, the colloquium was a remarkable success. Of the 260-odd members, about thirty per cent hailed from foreign countries, and more than half of these were British; but altogether eleven countries were represented. The presence of the directors of national centres for scientific research in two European countries, and of leading workers in the relevant fields in Great Britain and the United States, gives some indication of the interest aroused.

The programme was divided into three main sections. The first was devoted to descriptions of existing computing apparatus, and discussions of the engineering aspects of computer design; the second concerned itself chiefly with mathematical applica-

tions of computers; while in the third was discussed the extent to which useful analogies might be drawn between the functions of computing elements and those of the brain. Only a representative selection from the extensive proceedings can be attempted in this article, and much of importance must be omitted.

In the first section, accounts were given of most of the current digital computing projects in European countries, including Sweden and Switzerland, where relay-type computers have been developed. Several of the American projects were also described. Perhaps the most striking general feature of current computer-design as presented is the growing popularity of the magnetic drum. As an auxiliary store with moderate access-time, it appears among the components of most electronic computers, and at least one machine uses a drum as its high-speed storage element. The Williams storage system is also finding increasing application, with variations on the types of trace used to represent 0 and 1. It is significant, however, that in Dr. E. W. Cannon's account of the seven machines under construction in the United States as part of the programme of the National Bureau of Standards, the emphasis was on the diversity of techniques and design parameters used; and the hope was expressed that this would provide experience leading to the choice of optimal parameters.

The pilot model of the Institut Blaise-Pascal digital computer was demonstrated by Prof. Couffignal on the first afternoon, and aroused considerable interest and some debate. It is unconventional in employing gas-diode storage elements and flip-flop registers. Stored information can be read in one microsecond; but the writing time is much slower. The pilot model handles eight-digit numbers, using only two double-triodes for each digit.

An interesting development in the design of mechanical differential analysers was reported from Sweden by Dr. S. Ekelöf. An integrator of the wheel-and-disk type has been devised which requires no torque amplifier. In place of a single wheel, a pair of wheels is used, with differential coupling to the output shaft. The design is such that a sufficiently heavy pressure can be maintained on the contact surfaces to give adequate torque without amplification, both wheels being in rotation even when the net output is zero. The resulting simplicity and convenient layout of the complete analyser attracted much attention.

Reference was made in discussion to the recent development in Great Britain of ultra-high-speed electronic-analogue techniques employing three- and four-dimensional cathode-ray tube displays, whereby solution-rates of 10,000 per sec. become practicable. A number of elegant applications of other analogue devices such as resistance-networks and electrolytic tanks were also described.

The second section, like the first, included several valuable papers of rather a specialized nature. Among those of more general interest, however, that of Dr. A. van Wijngaarden on rounding-off errors in systematic calculations aired a subject which is of increasing importance now that higher speed encourages the undertaking of ever-longer calculations. He showed, in particular, that the treatment of rounding-off errors as random quantities can sometimes lead to surprising anomalies, which can only be avoided by a more careful analysis.

Dr. M. V. Wilkes's paper on operational experience of the electronic delay storage automatic calculator (EDSAC) also aroused much interest, by its treatment of problems of organization associated particularly with the employment of a computer by a number of different users. It was generally felt that a greater proportion of thought should now be devoted to such operational aspects of computation, and to the design of suitable problems to enable the highest efficiency to be extracted from a computer.

Of equally general interest was Dr. H. Aiken's discussion of an operational symbolism to enable the block-diagram of a computing system to be deduced directly from the specification of the problem which it must solve. In its simplest form the symbolism appears to neglect such factors as time-delay; but in principle it is possible by its use to determine the 'minimal circuits' necessary to fulfil any given function.

The third section made its transition to the discussion of neurophysiology through an exhibition of a number of most entertaining toys, designed to illustrate the possibility of simulating different animal functions mechanically. From the early and essentially non-retroactive chess-player and other devices of L. Torres-Quevedo, the members of the colloquium were led to the characteristically retroactive "mechanical tortoise" of Dr. W. Grey-Walter, which has been made to show a form of controlled phototropism and several other suggestive reactions by the ingenious exploitation of only two valves. Dr. W. R. Ashby's "Homeostat" illustrated a further step towards the resilience of animal life, by the provision of means for altering circuit connexions as well as feedback-currents.

Notable among succeeding papers were the American contributions from Dr. W. S. McCulloch on some of the differences between calculating machines and brains, Dr. N. Wiener on the mathematical identification of *Gestalt* or form, and Dr. Lorente de No on recent discoveries concerning the mechanisms of facilitation and inhibition of conduction in nerve fibres.

In other papers and in the succeeding discussion the field was further widened to include questions of a semi-metaphysical nature. The possibility that a machine might have a consciousness was hotly debated for some time, though to the writer it appeared that discussion was largely vitiated by the human habit of confusing complementarity with exclusion. This preference for black-and-white bedevils many inquiries of this nature, though the impropriety of begging the question of complementarity has been well enough demonstrated in other fields.

Among the more general issues raised in discussion, perhaps the greatest interest was aroused by the tender topic of terminology. In the field of computation the position was felt by many, particularly in non-English-speaking countries which had adopted British and American terms, to be chaotic. A French proposal that an international committee be set up to agree, if possible, on standard usage received a large measure of support. But leading voices could be heard in opposition; and Brigadier G. H. Hinds, of the British Ministry of Supply, observed that even in a single country in his recent experience it had not proved practicable to secure agreement on nomenclature in a related field. Prof. Couffignal, however, seemed more optimistic at least with regard to France, and further explorations of the question are likely.

The chief value of a conference of this kind is often not evident until afterwards. It would appear

that little of the synthesis suggested by the title was achieved, many of the papers being presented as isolated units which made no gestures of recognition to their context; and when human *thought* was nominally the subject, it was, perhaps, too often only human *logic* which was discussed. Undoubtedly, however, in the informal contacts which were established, as well as in the formal exchange of information, a valuable preparatory contribution has been made towards a deeper analysis of the processes mediating human thought. D. M. MacKay

CO-ORDINATION CHEMISTRY

A SYMPOSIUM on co-ordination chemistry, at which there was an attendance of forty, was held at the Butterwick Research Laboratories of Imperial Chemical Industries, Ltd., at Welwyn during September 21–22, 1950. The chairmen were Dr. J. Chatt (first day) and Dr. F. G. Mann (second day). The programme for the first day was concluded by a dinner and social evening, which provided an opportunity for an informal exchange of views. The guests were welcomed by Mr. M. T. Sampson, and Prof. N. V. Sidgwick opened the symposium with an account of the history of the subject up to about 1925.

Dr. F. G. Mann (Cambridge) discussed the complex derivatives of the tertiary phosphines and arsines with mercury and cadmium halides. The mercury complexes fall into five classes: (1) $[(R_3As)_3HgX_2]$; (2) $[(R_3As)_3(HgX_2)_2]$; (3) $[(R_3As)_2(HgX_2)_3]$; (4) $[(R_3As)_2(HgX_2)_4]$; (5) $[(R_3As)_3(HgX_2)_3]$. Cadmium also forms compounds similar to those in classes (1), (2) and (5). The structures of (4) and (5) are unknown. (1) has undoubtedly a simple tetrahedral structure and (2) the bridged structure. Certain compounds of class (3) occur in white and yellow forms. X-ray examination of the white form suggests that it consists of molecules of class (2) alternating with simple HgX_2 molecules, the complete arrangement providing a centre of symmetry. The yellow form has no centre of symmetry.

Prof. G. Schwarzenbach (Zurich) followed with a paper on the stability constants of chelate complexes in aqueous solutions. Bjerrum has shown that simple ligands are added on to metal ions one at a time with gradual falling-off in strength of attachment with each addition. The donor groups of a polydentate ligand are attached simultaneously; if several polydentate ligands are attached, each is much less strongly bound than the last. Prof. Schwarzenbach demonstrated that this simplifies the calculation of the equilibrium constants. It was shown that the geometry of the organic polydentate ligand and the stereochemistry of the metal ion affect the stability of the complex compound. These considerations render it probable that ligands capable of strong binding to any metal cation can be synthesized.

The stability of co-ordination compounds and the varying strengths of metal–ligand bonds was also discussed by Dr. H. Irving (Oxford). In the attachment of ethylenediamine to cobalt, nickel, copper and zinc, the entropy changes are relatively small, and if this is generally true the equilibrium constant for the successive stages in the formation of co-ordination compounds will serve as a measure of relative bond-strengths. The general order of stabilities of the divalent transition ion complexes was shown to be as follows:

$$Mn < Fe < Co < Ni < Cu > Zn.$$

Departures from this order are probably due to steric factors or a change in the bond orbitals used in bond formation.

Dr. R. S. Nyholm (University College, London) described the complexes of iron, cobalt, nickel and copper with *o*-phenylene*bis*(dimethylarsine) (=*D*), an exceptionally strong chelating agent. Magnetic susceptibilities of these complexes showed that the metal–ligand bonds are covalent. Univalent copper gives tetrahedral complexes $[CuD_2]X$ and $[CuD_2][CuX_2]$; bivalent iron, octahedral $[FeD_2X_2]$; and bivalent cobalt and nickel, planar $[NiD_2]X_2$ and $[CoD_2]X_2$. Octahedral tervalent complexes of iron, cobalt and nickel were also described, for example, $[FeD_2X_2]X^-$.

In discussing the co-ordination of olefins to platinous salts, Dr. J. Chatt (Butterwick Research Laboratories) briefly explained why he considered none of the structures previously proposed to be satisfactory. Evidence was presented that olefin complex formation probably involves a filled *d*-orbital of the metal atom in the manner suggested by Pauling for the carbonyls. For this bonding the ligand must have both a lone pair for donation to the metal (forming a σ-bond) and a vacant orbital to receive electrons from a *d*-orbital of the metal (forming a π-bond). Ethylene fits into this scheme if its complexes are ethylidene complexes, for example, $K[CH_3CH=PtCl_3]$, and the known reactions of olefin platinous complexes were explained in terms of this structure.

Dr. R. G. Wilkins (Butterwick Research Laboratories) described his experiments to determine the position of equilibrium between *cis*- and *trans*-$((n\text{-}C_3H_7)_3M)_2PtCl_2$ (M = P, As and Sb). The course of the isomerization was followed by measuring the change in dielectric constant of their benzene solutions. Whereas the arsenic and antimony complexes isomerize spontaneously, it was found that the equilibrium is labile in the phosphorus series only in the presence of a trace of added $(n\text{-}C_3H_7)_3P$. Evidence was presented that the former complexes produced the catalyst $(n\text{-}C_3H_7)_3M$ by their own dissociation. Preliminary experiments indicated values of K[=[*trans*]/[*cis*]] at 25° C. to be 30 (M = P), 55 (M = As) and 3·5 (M = Sb).

Some new five-covalent complexes of nickel and cobalt, $[NiBr_2(PEt_3)_2]$ and $[CoCl_2(PEt_3)_2]$, were described by Prof. K. A. Jensen (Copenhagen), who demonstrated the striking colour change which occurs when red $[NiBr_2(PEt_3)_2]$ is brominated to dark green $[NiBr_3(PEt_3)_2]$. Their magnetic susceptibilities and dipole moments indicate that they have the configuration of a square pyramid with the metal atom in the centre of the base, a halogen atom at the apex and the remaining groups at the corners of the base in *trans* configuration. Prof. Jensen has also found an unstable complex of trivalent nickel with dimethylglyoxime (DH), $Ni(DH)_2Br_2$, which by analogy with the above complex is assumed to have a Br_2 group attached to one side of the square $Ni(DH)_2$ complex.

In discussing the significance of *d*-orbital hybridization in co-ordination compounds from the point of view of quantum mechanics, L. E. Orgel (Oxford) showed that no accurate treatment is at present possible, but that the use of the overlap integral

$s = \int \psi_A \psi_B d\tau$ provides useful qualitative information. He stressed that overlap calculations suggest that Pauling's bond-strength values over-emphasize the difference between tetrahedral and octahedral bonds. His own calculations are consistent with bonding between the d_z-orbital of a central atom and the p_z- or d_z-orbitals of an attached group, and d_z–p_z hybridizations may be important in some compounds. If two d_z-bonds are formed by the central atom of a square complex, then, other things being equal, the *cis*-configuration will be more stable.

Dr. A. F. Wells (Imperial Chemical Industries (Dyestuffs), Ltd., Manchester) discussed the stereochemistry of atoms in crystals and distortion from ideal 'bond angles' by the geometrical requirements of the attached groups. He illustrated these points by reference to the crystal structures of divalent compounds of palladium, platinum and copper. Copper behaves uniquely and its compounds are not isomorphous with those of any other metal, owing to the peculiar co-ordination of copper which gives it four nearest neighbours at the corners of a square and two more distant neighbours completing a distorted octahedron.

Dr. L. E. Sutton (Oxford), in summing up, welcomed the introduction of physical methods into co-ordination chemistry. The following also contributed to the discussion: Prof. A. Albert (National University of Australia), Dr. J. S. Anderson (Atomic Energy Research Establishment, Harwell), D. C. Bradley (Birkbeck College, London), F. Burstall (Chemical Research Laboratory, Teddington), G. E. Coates (Bristol), Dr. D. P. Craig (University College, London), Dr. D. D. Eley (Bristol), Dr. M. E. Foss (Guy's Hospital, London), Dr. P. George (Cambridge), Dr. A. Maccoll (University College, London), Dr. W. G. Palmer (Cambridge), and Prof. W. Wardlaw (Birkbeck College, London).

R. G. WILKINS

FUNCTIONS OF THE NATURE CONSERVANCY

THE Committee of the Privy Council for Agricultural Research and Nature Conservation has issued a paper*, giving a short account in general terms of the functions and aims of the Nature Conservancy, to meet a demand for information about this body. A separate note dealing more particularly with the recruitment of staff and the award of maintenance allowances is available for *bona fide* inquirers. The present paper points out that the first two functions of the Conservancy, to provide scientific advice on the conservation and control of the natural flora and fauna of Great Britain, and to establish, maintain and manage Nature reserves, cannot be carried on without continuous scientific research to build up and maintain the essential body of knowledge and experience. This research will be conducted principally, but not exclusively, in the proposed Nature reserves, and the Conservancy can make grants in aid of specified researches to be undertaken by the universities or other research bodies and award maintenance allowances for the postgraduate training of suitable students. As a start, provisional laboratory accommodation is being attached to the Conservancy headquarters in London and Edinburgh, and the establishment of a fully equipped terrestrial research institute is under consideration.

The Conservancy has provisionally scheduled about a hundred and fifty places in Great Britain as National Nature Reserves. Of these, seventy to eighty in England and Wales and about thirty in Scotland are areas of biological or physiographical importance, while some forty are features of special geological importance and will be administered in the same way. When the areas finally selected have been accurately surveyed and delimited and either acquired or made subject to suitable management agreements, they will be declared National Nature Reserves under the Act. The Conservancy may also make by-laws for the protection of a National Nature Reserve, by controlling entry into, or movement within, a Reserve, the killing or taking of animals of any description, or interference with the vegetation and soil, and the lighting of fires, etc., and it may also control the killing of birds within surrounding areas; this last provision is necessary to avoid serious effects on the bird population of a reserve. Restriction of entry will only be applied where and when it is essential to serve the purposes for which the reserve was established. It is imperative that most of the reserves should be actively managed, and the Conservancy intends to train a staff to take charge of the reserves, to study continuously the effects of different kinds of treatment, to arrange for the destruction of pests, and to keep the plant and animal populations in balance. Some of the more important reserves will each have a resident officer who will participate in the necessary research as well as be responsible for day-to-day management. In others a single officer may be able to look after a group of reserves. Provision is also made for local Nature reserves to be established by local authorities in agreement with the Conservancy.

It is recognized further that Nature reserves alone cannot sufficiently provide for the general conservation of the flora and fauna, for comparative studies, or for the display of particular types of plant and animal communities on an adequate scale. The Conservancy is required to notify the local authorities concerned, or the agricultural departments and the Forestry Commission, of any other places of special scientific interest. The Conservancy cannot here, however, do more than seek to persuade the responsible authorities of the importance of scientific interests and to encourage general conservation of the flora and fauna and features of special geological importance by all concerned over much wider areas in which scientific interests, though important, cannot be paramount.

Finally, the paper seeks to make clear the distinction between the functions of National Parks and of National Nature Reserves, and in particular that while, so far as land is concerned, the first objective of the Nature Conservancy is the preservation as Nature reserves of good samples of the various types of natural and semi-natural vegetation with their accompanying animals, as well as the stations of rare and interesting species, the principal objective of reservation is scientific study. The Conservancy is convinced that properly organized study and research, carried on mainly in the reserves, is essential both for the increase of fundamental knowledge and for the future application of this to the proper management of National Parks and to the development of similar land for other uses.

* Committee of the Privy Council for Agricultural Research and Nature Conservation. The Nature Conservancy. Pp. ii+6. (Nature Conservancy, 91 Victoria Street, London, S.W.1, 1950.)

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

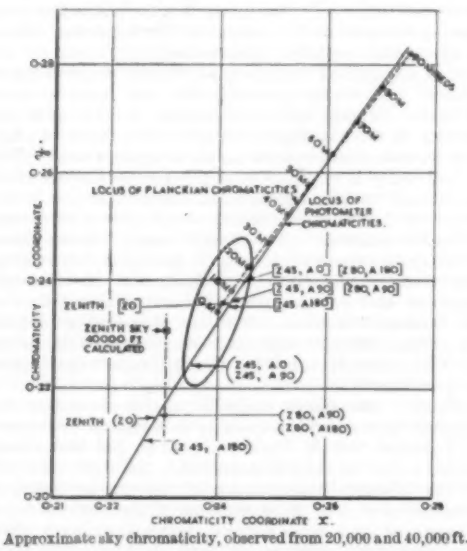
Colour and Brightness of the Sky

In a recent flight in a De Havilland 'Comet' aircraft, measurements were made of the chromaticity (colour), luminance (brightness) and polarization of the sky as observed at heights of 20,000 and 40,000 ft., and of the colour temperature and illumination of the sun's light at 40,000 ft. The results are briefly reported in this communication.

The observations were made over the south of England, above a gap in the clouds, at about 15.30 hr. (B.S.T.) in September 1950. The mean zenith angle of the sun was 62°. The cloud extended up to about 20,000 ft. and was estimated at 6/8 coverage. Readings were taken at zenith angles (Z) of 0°, 45° and near 90°, in four vertical planes making azimuthal angles (A) of 0°, 90°, 180° and 270° with the vertical plane containing the sun. For most of these directions there was opportunity to take only one reading; but for the zenith four values were obtained and their mean used. The values for $A = 90°$ and 270° were also averaged. Corrections were applied to allow for the various effects of the double 'Perspex' windows through which observations were made.

An indication of the sky chromaticity was obtained using a new portable colour-temperature photometer by means of which the sky was matched visually with chromaticities approximating to those of Planckian radiators[1]. These radiators provide reference standards for colour-temperature measurements, and their chromaticities can be calculated from the spectral distribution of energy given by Planck's formula. The approximation of these chromaticities to those of the photometer comparison field are shown in the accompanying diagram. It proved possible to obtain a close, but not in every case a perfect, colour match with the sky. The instrument chromaticities giving closest match in different directions of observation and at different heights are indicated by the arrows in the diagram. It will be noted that at 40,000 ft. the recorded chromaticity corresponds to a source bluer than a Planckian radiator of infinite temperature. In so far as the sky could not be perfectly matched in the photometer, it appeared slightly greener by an amount which it is estimated would not be inconsistent with a calculated value for the sky chromaticity, also shown in the diagram. Rayleigh scattering and the energy distribution of solar radiation outside the atmosphere as given by Moon[2] were assumed in this calculation. The colour temperature of the sun's light at 40,000 ft. was found to equal 5,800° K. (172 mireds).

A Macbeth illuminometer adapted to take a nicol was used for the luminance measurements, and the results after correction for window effects are given in the accompanying table.



Approximate sky chromaticity, observed from 20,000 and 40,000 ft.

The chromaticities produced by the photometer for a 'best match' with the sky are indicated by the arrows. The part of the sky observed is identified by its position with reference to the sun and is indicated by the zenith and azimuth angles in degrees. The height is indicated by square brackets [ ], for 20,000 ft., and round brackets ( ), for 40,000 ft. The ellipse indicates ten times the least perceptible difference in chromaticity from the 0 mired value. A mired is a million divided by the colour temperature in degrees Kelvin. The observer matches chromaticities not on the photometer chromaticity locus with those on the locus in the direction x = constant as shown by —·—·—·— through the calculated chromaticity of the zenith sky

Altitude and pressure	Zenith angle (Z)	Azimuth (A)	Sky luminance (candelas/sq.m.)	Polarization ratio
20,000 ft. (350 mm. Hg)	90°	0°	14,500	—
		90°	5,150	0·28
		180°	5,650	—
	45°	0°	2,150	—
		90°	1,140	0·32
		180°	840	0·31
	0°	—	1,070	0·50
40,000 ft. (140 mm. Hg)	90°	0°	4,000	—
		90°	1,220	0·44
		180°	1,370	0·66
	45°	0°	960	—
		90°	410	0·49
		180°	330	0·45
	0°	—	440	0·42

The polarization ratio is defined as the luminance with the nicol set to give a minimum reading, divided by the luminance with the nicol set to give a maximum reading. The actual nicol angles could not be recorded in the time available. The observations near the horizon ($Z = 90°$) were very sensitive to the exact direction of view and are correspondingly uncertain. Leaving these aside, it will be noted that the luminances at 20,000 and 40,000 ft. are approximately in the ratio of the atmospheric pressures, while the polarization ratio has about the same value at each height. These results accord with expectation. The absolute value of the luminance is about 30 per cent above an estimate made on the basis of Tousey and Hulburt's[3] theoretical and experimental work.

For the direct illumination produced by the sun on a surface normal to the rays, a value of 110,000 lux (10,200 lumens/sq. ft.) was obtained at 40,000 ft.

The work was carried out as part of the research programme of the National Physical Laboratory and in conjunction with the De Havilland Aircraft Co., British Overseas Airways Corporation and Messrs. Kelvin–Hughes, Ltd. This description is published

by permission of the Director of the Laboratory. We are particularly indebted to Mr. J. Cunningham and his co-pilots for the way in which they manœuvred the aircraft to enable the measurements to be made. We wish also to acknowledge the general advice of our colleague Dr. W. S. Stiles.

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Jan. 23.

[1] Harding, H. G. W., *Proc. Phys. Soc.*, **58**, 1 (1946).
[2] Moon, P., *J. Frank. Inst.*, **230**, 590 (1940).
[3] Tousey, R., and Hulburt, E. O., *J. Opt. Soc. Amer.*, **37**, 78 (1947).

A Scintillation Counter for Detecting Fast Neutrons

Fast neutrons can be detected by scintillation counters, using organic phosphors such as anthracene, by the proton recoils which they cause[1–3]. It is usually necessary, however, to detect the neutrons against a background of γ-rays, to which such counters are very sensitive. It is not in general possible to distinguish between neutrons and γ-rays by the use of a voltage discriminator after amplification, because organic phosphors give larger pulses from electrons than from protons of the same energy[4,5].

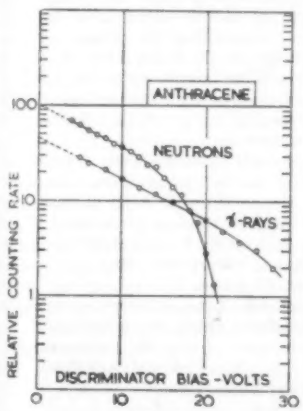

Fig. 1

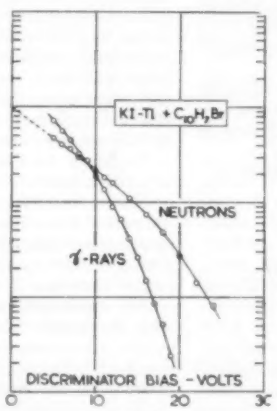

Fig. 2

Fig. 1. Relative counting-rates in anthracene for equal fluxes of 2·5-MeV. neutrons and 2·62-MeV. γ-rays

Fig. 2. Relative counting-rates in potassium iodide activated with thallium + α-bromonaphthalene for equal fluxes of 2·5-MeV. neutrons and 2·62-MeV. γ-rays

A greater sensitivity to neutrons relative to γ-rays would be obtained by detecting the recoil protons originating in a hydrogenous material in an inorganic phosphor, such as potassium iodide activated with thallium, which gives nearly the same response to protons and electrons[5]. A further increase in the relative sensitivity to neutrons could be obtained by using layers of such activated potassium iodide of thickness of the order of the maximum proton-range, interspersed with layers of hydrogenous material of thickness of the maximum electron range. A proton starting from just outside the potassium iodide layer would then lose all its energy in the phosphor, while an electron could never lose more than a small fraction of its energy.

The construction of such a system would be difficult, and further difficulties would be met in collecting the light emitted. As a substitute, therefore, a powder of potassium iodide activated with thallium was used, in which the size of all the crystals was of the order of the range of 2-MeV. protons (10 μ). The interstices in the powder were filled by a hydrogenous liquid, α-bromonaphthalene, $C_{10}H_7Br$, which has the same refractive index as the activated potassium iodide at the wave-length of its fluorescent light, in the manner of a Christiansen filter[6]. This mixture, which contained approximately equal volumes of the potassium iodide and α-bromonaphthalene, was reasonably transparent to blue light. It was sealed in a glass capsule 2 cm. long and 2 cm. in diameter, from which all the air had been removed.

The light loss from the mixture was measured by placing the capsule and an activated potassium iodide crystal in turn on the window of a Type 5035 photomultiplier tube, surrounded by a mirror, and irradiating them with the same flux of γ-rays from cobalt-60. From these experiments it was deduced that the transmission of the fluorescent light by the mixture is lower than that of the single crystal by a factor 2·8.

The relative sensitivities to neutrons and to γ-rays of the mixture and of anthracene were then measured by irradiating each in turn with 2·5-MeV. neutrons from the D—D reaction and 2·62-MeV. γ-rays from radiothorium. Bias curves were plotted under similar conditions and are shown in Figs. 1 and 2. The curves in the figures do not show the actual counting-rates, but those which would have been obtained if the fluxes of neutrons and γ-rays had been the same. This adjustment was made using the ratio of the fluxes obtained from the measurements on the anthracene crystal, together with the known cross-sections for neutrons and γ-ray absorption in this substance.

Using anthracene, the ratio of the number of neutron counts to the number of γ-counts has a maximum value of 2·2 at zero bias and decreases with increasing bias. With the mixture, however, this ratio increases with increasing bias, and has a value of 10 when the discriminator setting is such that 5 per cent of the neutrons absorbed in the mixture are counted. The number of 2·5-MeV. neutrons counted would then be 0·8 per cent of those falling on a detector 2 cm. thick.

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Dec. 7.

[1] Hofstadter, R., Brookhaven Internal Report BNL-I-7 (1948).
[2] Bell, P. R., *Phys. Rev.*, **73**, 1405 (1948).
[3] Wouters, L. F., *Bull. Amer. Phys. Soc.*, **24**, No. 2, 20 (1949).
[4] Kallmann, H., *Phys. Rev.*, **75**, 623 (1949).
[5] Franzen, W., Peelle, R., and Sherr, R., *Bull. Amer. Phys. Soc.*, **25**, No. 3, 18 (1950).
[6] Christiansen, C., *Ann. Phys. u. Chemie*, **23**, 298 (1884); **24**, 439 (1885).

A Radar Echo from Lightning

Radar observations on rain clouds are being made at Cambridge, using a vertically directed beam with a half-width of 3° to half-power, a peak power of 40 kW. with a 1 μsec. pulse on a wave-length of 3·2 cm., and a range-amplitude display ('*A*-scope'). The same aerial is used both for transmitting and for receiving.

During a violent thunderstorm on July 6, 1950, an intense echo of duration about 2 msec. was observed at a height of 12,000 ft. This echo was sufficiently strong to saturate the *A*-scope, so that its intensity is known to have been at least 2×10^{-4} watts. At the same instant, a strong positive field-change was recorded at the ground on a point discharge-current apparatus. Accordingly, the possibility that the echo might have originated from a lightning discharge was investigated and the following conclusions reached.

The dielectric discontinuity between the hot air in the interior of a lightning column and the surrounding air would at best give an echo intensity 10^{-10} of the observed intensity. Direct radiation from the discharge on a frequency of 10,000 Mc./s. seems most unlikely. However, the echo could have been produced by a cylindrical column of electrons, and, using a method due to Blackett and Lovell[1], the electron concentration necessary to give an echo of the strength observed was computed as 5×10^{13} electrons/cm. length. The damping produced by electron collisions with neutral atoms and positive ions was taken into account, and the assumptions were made that the column lay along a diameter of a horizontal cross-section of the beam and that the diameter of the discharge column was less than one wave-length. In fact, only a short length of the column may have lain perpendicular to the beam, so that the estimated electron concentration is a lower limit.

This note is prompted by a recent report[2] on radar lightning echoes, where, however, no estimates are given of absolute echo intensities or of conditions in the discharge.

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Jan. 3.

[1] Blackett and Lovell, *Proc. Roy. Soc.*, A, **177**, 183 (1941).
[2] Ligda, Myron G. H., *Bull. Amer. Met. Soc.*, **31**, 279 (1950).

A New Gem Mineral

In November 1945, Count Taaffe, a Dublin gemmologist, asked us to identify a pale mauve faceted gem-stone in which, though ostensibly a spinel, he had detected small but distinct double refraction by direct observation under a binocular microscope.

The properties of the stone (which weighed 1·41 carats) were found to be: refractive indices $\omega = 1{\cdot}723$, $\varepsilon = 1{\cdot}719$, uniaxial negative; density 3·62; hardness 8 on Mohs's scale. Apart from the birefringence, it will be seen that these properties are very close to those for spinel; but an X-ray examination showed conclusively that the stone had hexagonal symmetry and belonged to a new mineral species. The unit cell dimensions are: a, 5·72; c, 18·38 A., and the space group is $D^6_3 = C6_32$. A spectrograph of a small fragment showed the presence of magnesium, beryllium and aluminium.

Recently, one of us (C. J. P.) discovered a second specimen (weighing 0·87 carats) of the new mineral among a mixed parcel of coloured stones, during a routine test. This had very similar properties to the first, and its identity was further substantiated by X-ray examination. More accurate refractive index measurements were obtainable on this specimen, using an Abbe–Pulfrich refractometer, the indices being $\omega = 1{\cdot}7208$, $\varepsilon = 1{\cdot}7167$.

Thus far, only these two cut specimens are known, and the origin of the mineral must remain uncertain, though in each case the stones were accompanied by others which definitely came from Ceylon, and the first specimen was typically Ceylon-cut. This is probably the only instance where a new mineral has been first encountered as a cut gem-stone.

Count Taaffe kindly allowed the removal of a small portion of his stone for microchemical analysis. When this has been completed a fuller report will be sent to the *Mineralogical Magazine*.

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Upper Limit of Frequency for Human Hearing

Effects similar to those reported by Pumphrey[1] were demonstrated to us in December 1945 by Dr. Maass of Bremen[2]. According to Maass, bone-conducted vibrations up to 50 kc./s. (150 kc./s. or more in the young) can be heard by most people, including some subjects normally regarded as totally deaf at ordinary frequencies both to air-borne and to bone-conducted sound.

Contrary to Pumphrey's findings with a resonant crystal transducer and an oscillator of continuously variable frequency, Maass showed, with a magnetostriction transducer and a choice of several fixed frequencies between 30 and 60 kc./s., that the tones could be distinguished in pitch, sounding not unlike tones between 8 and 16 kc./s.

No systematic work had been done to investigate the possibility of ill effects from the vibrations.

J. H. Combridge
J. O. Ackroyd

Post Office Engineering Department,
London, E.C.1.
Dec. 8.

[1] Pumphrey, R. J., *Nature*, **166**, 571 (1950).
[2] Combridge, J. H., and Ackroyd, J. O., B.I.O.S. Final Report No. 606 (1946).

If it is true that persons totally deaf in the range of normally audible sounds (30–16,000 c.p.s.) can perceive sound by bone-conduction in the range 16,000–100,000 c.p.s., this is a fact of great importance both for the theory of hearing and for the design and construction of hearing-aids, particularly if perception is associated with any useful degree of frequency discrimination above 16 kc./s.

I am sceptical about this report; first, because I am dubious about the assessment of total deafness; secondly, because, from my own observations, I am satisfied that frequency discrimination in the generally accepted sense (namely, monotonic relation of pitch

to frequency) is not possible above 16 kc./s. Maass's result, as reported, is open to the criticism that a magneto-striction oscillator with several fixed frequencies is not a suitable instrument for investigating frequency discrimination. I can confirm that, when the output of the transducer, applied to the mastoid or frontal regions, greatly exceeds the threshold, differences in quality of sound are perceived between arbitrarily chosen frequencies above 16 kc./s. These differences are heard as differences in purity rather than in pitch; since the impedance which couples the transducer to the cochlea is certainly non-linear, they can be attributed to the differential excitation of resonances in the audible range in the structures and cavities of the skull, or in the basilar membrane itself. They disappear when the stimulus intensity is reduced, and a sound is heard which varies only in loudness as the frequency is varied between 16 and 100 kc./s.

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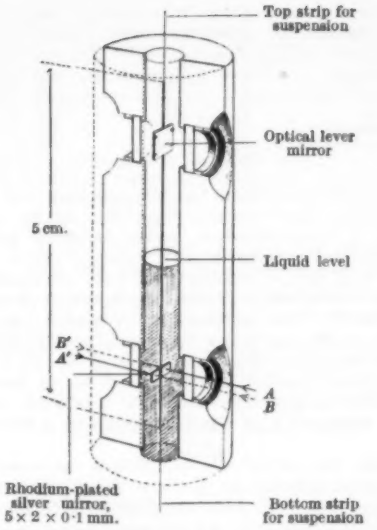
Radiation Pressure in a Refracting Medium

The measurements of electromagnetic radiation pressure in a vacuum by Lebedew[1], and by Nichols and Hull[2], are among the classic experiments of physics. All the theories that predict this pressure also predict that it should increase in a refracting medium. On the early corpuscular theory, the corpuscles are accelerated as they pass into a medium of higher refractive index; on the wave theory, the energy density increases as the waves slow down in the denser medium; on quantum theory the corresponding momentum of each photon increases, since it is equal to h/λ (where h is Planck's constant and λ is wave-length). An experiment to detect the increase of radiation pressure in an optically denser medium is not a crucial one, since the expected increase on each theory is the same; nevertheless, it is desirable that the increase should be observed.

An indirect test could be based on the fact that the passage of radiation from one medium to another should cause a mechanical reaction on the interface from the denser side and normal to the interface, the direction of the reaction being independent of the direction of the incident radiation. In effect, this reaction was observed in Barlow's experiment[3], where the transverse displacement of a beam of light passing obliquely through opposite sides of a cube of glass was shown to cause a torque on the cube. Barlow's experiment might be open to the minor objection that it does not by itself determine separately either the magnitude or the normality of the pressure. A more direct test would be to suspend a plane reflecting vane so that it could be rotated by the pressure of radiation reflected from it, and to immerse the suspension successively in air and liquids of differing refractive indices.

The difficulties in the way of the direct test are primarily those due to convection and radiometer effects, and it is perhaps for these reasons that the experiment has hitherto (apparently) not been performed. It is a fact, however, that convection currents can be minimized by making the suspension and its container small; and Tear[4] showed that radiometer effects in most gases are negligible at atmospheric pressure. A design of suspension has therefore been evolved from Tear's which takes account of these facts; the accompanying diagram shows the moving element of the suspension, and part of the container.



A quick-response (less than 1 sec.) system is used in order to differentiate between the effect of radiation pressure, which is immediate, and thermal effects, which take a few seconds to build up. A stretched suspension is used, the lower strip providing an anchor which prevents the surface tension of the liquid from drawing the suspension to the side of the tube. The vane is of silver, to minimize temperature differences between side and side, and front and back, of the mirror due to the fraction of the incident light which is absorbed by the mirror. The vane is rhodium-plated to give a highly reflecting and non-tarnishing surface. The radiation is made to fall simultaneously from opposite directions on opposite sides of the vane at positions AA', and is then switched to positions BB', when the couple on the vane should change sense. The resulting deflexion is found for radiation from a tungsten filament (filtered through a cell of the same liquid as will be used to surround the suspension) first when the suspension tube is filled with air, and then when it is filled with liquid to the level shown in the diagram. The deflexion of the suspension is recorded by means of an optical lever and photo-electric amplifier operated by the upper mirror.

In air, the deflexion consequent upon switching the radiation from AA' to BB' rises to an equilibrium value as quickly as the response of the suspension will allow. In liquids, the deflexion generally goes through three phases: (i) it rises within 1 sec. to some value, (ii) it decreases during the following few seconds to a value which may be between 20 and 90 per cent of the first, (iii) thereafter it again increases to a value between 1 and 5 times the first. Whatever the explanation of the second and third phases (the former may be due to the changing temperature on the front and back of the vane, and the latter to convection effects), the interesting phase is obviously the first. The observed ratios of the initial kick in several liquids to the corresponding deflexion in air (θ (liquid)/θ (air)), with all other experimental conditions unchanged, are shown in the accompanying table.

Medium	Refractive index	θ (liquid)/θ (air)
Water	1·33	1·36 (1·31)
Ethyl ether	1·35	1·44 (1·39)
Ethyl alcohol	1·36	1·42 (1·37)
Xylene	1·50	1·50 (1·44)
Benzene	1·50	1·53 (1·47)
Nitrobenzene	1·55	1·50 (1·44)
Carbon disulphide	1·63	1·65 (1·59)

A high accuracy should not be expected from these preliminary observations, since the angles of deflexion of the suspension under radiation pressure are only of the order of 10^{-5} radian; errors up to 10 per cent are to be expected from Brownian and other disturbances. The deflexion ratios should be corrected for the reflexion loss between the glass window of the suspension tube and the liquid inside, this loss being less than when air is inside, by 3–4 per cent; the corrected figures are given in brackets. No allowance has been made for a possible change in the reflectivity of the vane when in a refracting liquid.

Within the limits of its present accuracy, the experiment appears to confirm the theoretical expectation that the radiation pressure increases in a refracting medium in proportion to the refractive index.

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Dec. 16.

[1] Lebedew, P., *Ann. der Phys.*, **6**, 433 (1901).
[2] Nichols, E. F., and Hull, G. F., *Phys. Rev.*, **2**, 26 (1903).
[3] Barlow, G., *Proc. Roy. Soc.*, A, **87**, 1 (1912).
[4] Tear, J. D., *J. Opt. Soc. Amer.*, **11**, 135 (1925).

Hyperconjugation and Light Absorption

The replacement of the hydrogen of a methine group in a number of conjugated organic compounds by an alkyl radical causes a batho- or hypso-chromic shift in the principal absorption maxima. This effect is particularly noticeable in methyl substitution, and could be explained by the hyperconjugation introduced by the methyl group.

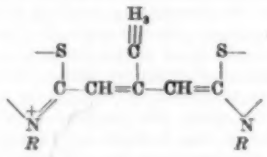
There is a hypsochromic shift of 300 A. in the absorption maximum of phenyl methyl ketazine on that of benzylideneazine[1], due to the contribution of a shorter conjugated form:

$$H_2{\equiv}C{-}CPh{=}N{-}N{=}CPh{-}C{\equiv}H_2$$

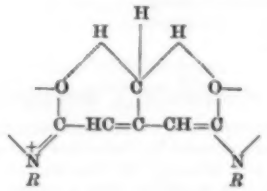
to the total resonance system.

The absorption maximum of the 2 : 4 dinitrophenylhydrazone of acetaldehyde in ethanol shows a bathochromic shift of 120 A. on that of its formaldehyde homologue. The three consecutive higher homologues show, however, a bathochromic shift of only 90 A., which is 30 A. less[2]. The large bathochromic shift given by the acetaldehyde derivative could be explained on the basis of an extension of the conjugated chain through the hyperconjugation of the methyl group, which effect is felt to a less degree in the homologues.

The absorption maxima of thia- and selenacarbocyanines with an alkyl group substituted in the central position of their three-carbon methine chain show a hypsochromic shift on those of the unsubstituted compounds. This shift is, again, most pronounced with the methyl substituent[3]. In a system of this type, a possible contribution to resonance would be that of the shorter and less-charged conjugated chains extending from the nitrogen of the heterocycle to the methyl group:



This hypsochromic shift does not appear in the oxacarbocyanines[3], in which there is the possibility of an annulment of the hyperconjugative effect of the alkyl group because of hydrogen bonding between the alkyl group and the oxygen of the heterocycle, leading to the formation of a six-membered ring:



The effect of alkyl substitution in oxacarbocyanines on light absorption is that of weighting the molecule, and therefore only a small bathochromic shift of the absorption maxima is observed.

The hypsochromic effect cannot be ascribed to steric hindrance. Neither in the azines nor in the cyanines is the methyl substitution in the methine chain likely to force the systems out of their coplanar configuration[1,4]. Also, in the cyanines the introduction of substituents on the central atom of the three-carbon methine chain does not depress the sensitizing action[3].

It is significant that with the 2 : 4-dinitrophenylhydrazones[3] and with the simple thia- and selenacarbocyanines[3], the shift of the maxima brought about when an ethyl or higher alkyl group is introduced is approximately three-quarters of the shift caused by replacing the hydrogen atom by a methyl group. A similar ratio applies to the hyperconjugative effect of *p*-methyl and *p*-ethyl substitution on the hydrolysis of benzhydryl chloride[4,5].

A detailed investigation is now in progress on the influence of substitution of this nature on the light absorption of conjugated compounds.

M. Pianka
H. C. Barany
C. G. Smith

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Nov. 10.

[1] Barany, H. C., Braude, E. A., and Pianka, M., *J. Chem. Soc.*, 1898 (1949).
[2] Braude, E. A., and Jones, E. R. H., *J. Chem. Soc.*, 499 (1945).
[3] Brooker, L. G. S., and White, F. L., *J. Amer. Chem. Soc.*, **57**, 2480 (1935).
[4] Hughes, E. D., Ingold, C. K., and Taher, N. A., *J. Chem. Soc.*, 955 (1940).
[5] Arnold, R. T., Murai, K., and Dodson, R. M., *J. Amer. Chem. Soc.*, **72**, 4193 (1950).
[6] Blout, E. R., Eager, V. W., and Gofstein, R. M., *J. Amer. Chem. Soc.*, **68**, 1983 (1946).

Application of Paper Chromatography to the Separation of Non-Volatile Carboxylic Acids

THE separation of several non-volatile carboxylic acids by paper chromatography has been described by Lugg and Overell[1,2]. These workers found that it was impossible to carry out the separation with neutral solvents because the ionization of the acids caused the spots to 'tail'. They overcame the difficulty by swamping both the stationary and mobile phases with formic or acetic acid. Removal of the swamping acid was then a necessary and sometimes tedious operation before the non-volatile acids could be revealed by spraying with an acid-base indicator.

I have now succeeded in separating several non-volatile acids as anions. In a previous communication[3] describing the separation of the volatile fatty-acid anions, it was pointed out that the acids possessing more than one carboxyl group did not move from the starting line when *n*-butyl alcohol saturated with 1·5 *N* ammonium hydroxide was used as the mobile phase. The use of ethyl alcohol – ammonia overcomes this difficulty, and since the water-content of the solvent can be adjusted to any desired level, the flexibility of the method is greatly increased. As expected, the excursions of the acids become greater as the proportion of water in the solvent is increased, so that a pair of acids possessing similar R_F values at low concentrations of water (for example, malic and tartaric) can be completely separated by increasing the proportion of water in the solvent (see table).

R_F VALUES OF NON-VOLATILE CARBOXYLATE IONS IN ETHYL ALCOHOL - AMMONIA ON WHATMAN NO. 1 PAPERS

Ion	EtOH : 15*N* NH_4OH : H_2O = 90 : 5 : 5 v/v		EtOH : 15*N* NH_4OH = 95 : 5 v/v
	Ascending	Descending	Descending
Citrate	0·01	0·07	0·01
Oxalate	0·04	0·15	0·03
Tartrate	0·05	0·18	0·05
Malate	0·07	0·28	0·08
Adipate	0·20	0·44	0·21
Lactate	0·42	0·61	0·44

Development of the papers after drying (5 min. at 95° C.) can be carried out in two ways. Spraying with chlorophenol red (40 mgm. in 100 ml. water adjusted to *p*H 7) reveals the anions as bright yellow spots on a mauve background. Alternatively, by spraying with ammoniacal silver nitrate solution (equal volumes of 0·1 *N* silver nitrate and 5 *N* ammonium hydroxide) and heating at 95° C. for 5 min., the citrate, tartrate, malate and lactate ions are revealed as intense yellow fluorescent spots under an ultra-violet lamp. The adipate and oxalate ions give less intense white fluorescent spots.

Since the acids examined in this work are non-volatile, they can be applied to the paper as such, and recourse to the sodium salts is unnecessary. This is an advantage, because with ethyl alcohol as the mobile phase the sodium ion travels a sufficiently great distance to interfere with the excursions of some of the carboxylate ions. In general, spots containing approximately 10 μgm. of each acid were introduced on the starting line; this concentration gave readily detectable spots on spraying, although amounts so low as 5 μgm. could be detected.

An unexpected feature noticed in this work has been the large differences in the R_F values obtained by the conventional descending chromatographic method[4] and the ascending method of Williams and Kirby[5]. Values are shown in the accompanying table.

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[1] Lugg, J. W. H., and Overell, B. T., *Nature*, **160**, 87 (1947).
[2] Lugg, J. W. H., and Overell, B. T., *Aust. J. Sci. Research*, A, **1**, 98 (1948).
[3] Brown, F., and Hall, L. P., *Nature*, **166**, 66 (1950).
[4] Consden, R., Gordon, A. H., and Martin, A. J. P., *Biochem. J.*, **38**, 224 (1944).
[5] Williams, R. J., and Kirby, H., *Science*, **107**, 481 (1948).

Trichloracetic Acid and Feulgen Staining

THE importance of trichloracetic acid as an agent for the removal of nucleic acids from their combination in nucleoproteins has been amply demonstrated by Schneider[1]. The method is now widely used by various authors in different cytochemical procedures. In order to find out whether any differential reactivity of the chromosome parts—namely, euchromatin and heterochromatin—with fuchsin sulphurous acid appears after such treatment, experiments were carried out, mainly on root-tips of *Allium cepa* and *Hordeum vulgare*. A series of different concentrations of trichloracetic acid was prepared and the root-tips treated under different conditions.

It has been noted that heterochromatin, particularly of metaphase chromosomes, becomes sharply stained if the root-tips after fixation in acetic alcohol are treated with 0·25 *M* trichloracetic acid at 60° C. for 40 min., followed by hydrolysis in hydrochloric acid for 20 min. at the same temperature. The heterochromatin, particularly that of the centromeric and telomeric regions, stains sharply in leucofuchsin, the rest of the chromosome remaining unstained. Regions of secondary constrictions, which are also considered to be heterochromatic in nature, show no staining at all at any of the concentrations used. The preparations look similar to those of Levan[2], obtained after mercuric nitrate treatment in his '*Allium* test'.

One interesting feature which has been noticed during these trials, namely, hydrolysis in *N* hydrochloric acid in the Feulgen staining, can safely be substituted by a treatment in 0·25 *M* trichloracetic acid for 50 min. at 65° C., resulting in a sharp staining throughout the chromosome parts. When such treatment is followed by the action of *N* hydrochloric acid at the same temperature for 20 min., complete removal of the nucleic acids takes place. Staining with fuchsin-sulphurous acid without hydrolysis in *N* hydrochloric acid shows clearly that either the splitting of the purine bases according to Feulgen and Rossenbeck[3], or the splitting of the sugar linkages, too, engaged in polymeric bonding of nucleic acid, liberating the aldehyde groups as has been claimed by Overend and Stacey[4], is effected in such a treatment with trichloracetic acid. The effect, moreover, remains similarly pronounced when longer treatment is given with a slightly lower dilution of trichloracetic acid.

The complete disappearance of nucleic acids from the chromosomes in preparations where materials treated with trichloracetic acid are subjected to further treatment with *N* hydrochloric acid brings out clearly the property of the latter in detaching the nucleic acid from its combination with proteins. The results demonstrate the importance of trichloracetic acid in the Feulgen reaction, as well as the reactivity of that acid and *N* hydrochloric acid with the nucleic acids.

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[1] Schneider, W. C., *J. Biol. Chem.*, **161**, 293 (1945).
[2] Levan, A., *Hereditas*, **32**, 449 (1946).
[3] Feulgen, R., and Rossenbeck, H., *Z. physiol. Chem.*, **135**, 203 (1924).
[4] Overend, W. G., and Stacey, M., *Nature*, **163**, 538 (1949).

An Industrial Dermatosis due to Enzyme Action

Labourers in factories in South Malaya who cut up pineapples by hand for canning invariably show an abnormality of those parts of the body which are exposed to slight pressure and pineapple juice, notably the palmar surfaces of the fingertips and the periphery of the palms. At the beginning of the canning season, the left hand, which comes more into contact with the fruit than the knife-holding hand, becomes sore and small superficial raw areas on the fingertips are often seen. Within several days, however, these heal, and the skin ceases to be sore. The labourers state that this tolerance to the pineapple juice is due to the development of an abnormality of the skin, which in the affected area becomes bluish-white and so smooth that fingerprints may be completely lost. Deep cracks are sometimes seen in the region of the skin creases. These often stay raw and bleeding for a long time, and show no clinical signs of infection, presumably because of removal of dead tissues by enzymatic action.

The rapid development, universal occurrence and localization of the lesion to areas exposed to juice suggested that the dermatosis was due to a direct irritant and not to a sensitizer. Among other things, pineapple juice contains sugar (8·2–15·2 per cent), citric acid (0·3–1·1 per cent)[1] and the papain-like proteolytic enzyme bromelin, 0·16 per cent[2].

Samples of palmar stratum corneum from twelve labourers were stained by Gram's method, and cleared in aniline oil and examined microscopically for yeasts and fungi. Unlike the situation in certain Californian fruit-canning factories, where a yeast is responsible for lesions of the hands[3], yeasts were found in small numbers only in four cases out of twelve, from which it was thought that they played no important part in the development of the dermatosis.

Efforts were made to determine the factor in pineapple juice responsible for the lesions. Pineapple juice rubbed on the skin of the forearm or thigh, using a controlled method which, by itself, is sufficient only to induce mild erythema, produces a marked stinging itch followed by erythema and leading to the formation within fifteen minutes of a raw, bleeding area with whealing and weeping of fluid. Filtering the juice, which removes the needle-like crystals of calcium oxalate found in the pineapple, does not prevent the lesions; however, they are prevented if the juice has previously been boiled for ten minutes.

Citric acid is not thought to play an important part, since it produces no effect when rubbed on to intact skin as a six per cent aqueous solution.

Bromelin, prepared by Prof. J. W. H. Lugg of this University, was found to produce the same changes when rubbed on to the skin as does whole pineapple juice. Papaya latex with its high papain content produces similar but more severe lesions.

These enzyme-containing solutions do not exert any action when placed on the skin for so long as twenty-four hours without rubbing, whereas marked changes are rapidly produced with gentle rubbing. The continuous immersion in water raised the question as to whether this was a contributory factor, and to test this out the hands of scrap-rubber millers and sheet-rubber washers were examined. These labourers work with hands continually wet with water, and in contact with somewhat dirty rubber. Epidermal ridges were present and none of the changes found in pineapple labourers was seen. Circular erosions spreading peripherally from the palmar flexures were commonly seen, in the walls of which were found large quantities of fungal hyphæ.

The observations described lead to the conclusion that the dermatosis of pineapple cutters is due to bromelin, with mild mechanical force applied to the hand as a necessary accessory factor. Histologically, there are some differences from normal skin. The stratum granulosum is poorly developed, and when overstained with Delafield's hæmatoxylin and treated with glacial acetic acid, alternating layers of the stratum corneum are seen which are still stained deeply with hæmatoxylin, resembling keratohyalin in this respect.

It is probable that other dermatoses due to proteolytic attack on the skin occur in other industries, notably among people engaged in gutting mackerel and among slaughterhouse workers. The dermatosis here reported leads to little discomfort and no loss of working time, and could be prevented if the workers always wore the gloves provided for them.

An epithelium which for a large part of the day is developing in contact with a proteolytic enzyme is a complex system which might provide a useful experimental situation for students of skin and of protein chemistry. The nature of the change responsible for the histological difference of the skin of the labourers, and for the habituation of the workers to pineapple juice at the beginning of each season, is obscure. It is likely that the changes which lead finally to the production of keratin are modified, and that some of the non-keratin protein of the skin has been removed by digestion.

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[1] Tressler, D. K., Joslyn, M. A., and Marsh, G. L., "Fruit and Vegetable Juices" (New York, Avi Publishing Co., 1939).
[2] Tauber, H., "Enzyme Technology" (New York, John Wiley and Sons, 1943).
[3] Kingery, L. B., and Thienes, C. H., *Arch. Dermat. and Syph.*, **11**, 186 (1925).

Eruption of the Permanent Teeth in the South African Fossil Ape-men

THE great collection of skulls of *Paranthropus crassidens* made at Swartkrans in the past couple of years gives us not only nearly every detail in the structure of the skull and dentition, but also very satisfactory evidence of the sequence of the eruption of the permanent teeth.

A. H. Schultz has recently shown[1] that in all man-like apes and in the majority of monkeys the sequence of eruption is very definite (brackets show variation) :

$$M_1,\ I_1,\ I_2,\ M_2,\ (P,\ P),\ (M_3,\ C).$$

The premolars are variable, and M_3 and C may vary in order. But the 2nd molar is always the fourth tooth to erupt, and the canine is either the last or the second last tooth to erupt.

In *Sinanthropus*, Neanderthal man and Bushman, the sequence of eruption is almost as in all anthropoids and most monkeys. But in modern white man the sequence is very different. Schultz gives it as :

$$(I_1,\ M_1),\ I_2,\ (P,\ C,\ P),\ M_2,\ M_3.$$

Here it will be observed that the 1st incisor usually appears before the 1st molar, and while the canine and premolars are variable in their eruption they all appear before the 2nd molar, which is the second last tooth to erupt.

When we look at the sequence in *Paranthropus crassidens* we find the 1st incisors appear before the 1st molar; the canine appears about the same time as the 1st premolar: this is followed by the 2nd molar, the 2nd premolar, and lastly the 3rd molar. The sequence may be expressed thus :

$$I_1,\ M_1,\ I_2,\ (C,\ P_1),\ M_2,\ P_2,\ M_3.$$

It will be noted that this sequence differs very markedly from that in all anthropoids and most monkeys, and agrees closely with that of modern man, the only difference of note being that the 2nd molar appears before the 2nd premolar.

If there are still those who hold that *Paranthropus* (in spite of having a brain of probably more than 1,000 c.c. in the male and of possibly more than 850 c.c. in the female) is only an anthropoid ape, it is interesting to find that it has a dental sequence that is unknown in any living anthropoid or monkey, and is almost identical with that in *Homo sapiens*. It is further of interest to find that in this character it is much nearer modern man than is Pekin man, or Neanderthal man or even the Bushman.

Two years ago, Prof. Dart described an ape-man jaw from the northern Transvaal under the name of *Australopithecus prometheus*. This jaw shows a dental sequence quite unlike that of the Swartkrans ape-man and probably identical with that of anthropoids and some early types of man. The sequence is

$$(I_1,\ M_1)\ I_2,\ M_2,\ P_1,\ P_2,\ (C,\ M_3).$$

This difference in dental sequence may show that we have perhaps been right in holding that our South African ape-men belong to different species, and perhaps even to different genera.

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[1] Schultz, A. H., *Proc. Amer. Phil. Soc.*, 428 (Oct. 1950).

Placentation in Père David's Deer, *Elaphurus davidianus*

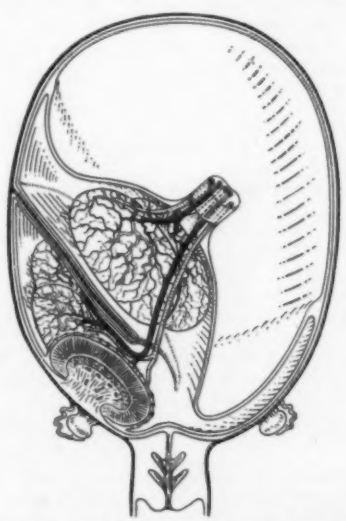
DESPITE the voluminous literature on the placentation of the Artiodactyla, we can find no reference to that of Père David's deer. Recently, His Grace the Duke of Bedford generously made available to us three specimens of the genital tract of this rare animal which now only survives in domesticity at Woburn Park and in certain zoological gardens.

The keeper at Woburn Park informs us that mating occurs in July; but the stags begin the 'rounding up' of the hinds in June. Mating usually occurs at night. Parturition has been reported in early April, but the usual date is mid-April to May; the latest date recorded was in September, the latter being a twin pregnancy.

The first of the specimens, a hind, ten years old, was killed on February 13, 1950. It contained a female fœtus 38 cm. in crown-rump length and which weighed 3·1 kgm. after fixation. The second and third specimens were killed on January 10, 1951, and contained a female fœtus (crown-rump length 36 cm., weight after fixation 2·515 kgm.) and a male fœtus (crown-rump length 33 cm., weight after fixation 1·98 kgm.) respectively.

Each gravid uterus was in the form of a sphere (75–90 cm. in circumference), and it was impossible to determine the position of the non-pregnant horn on external examination. The ovaries were found on the dorsal aspect some 7 cm. on each side of the firm fibrous cervix. In all three specimens the right ovary possessed a single corpus luteum.

On opening the uterus, it was found to be unequally divided by a thin, obliquely placed septum, nine to ten inches in length, into a larger space containing the fœtus and part of the placenta and a smaller space containing the rest of the placenta. The two spaces represent the much-dilated uterine horns. The lower crescentic edge of the septum lay above the cervix, and through the space thus formed passed the chorionic sac, the allantois, together with an umbilical artery and vein (see accompanying figure).



Diagrammatic drawing of the interior of the gravid uterus indicating the arrangement of the chorion, amnion, allantois and cotyledons

The chorionic sac fills the entire uterine cavity and exhibits five large cotyledons. The cotyledons are convex, ovoid in shape, and the arrangement and number of the cotyledons are similar in all three specimens. There are two large cotyledons in each right horn measuring 10–12 cm. in length, 6–8 cm. in thickness and 4–7 cm. in depth. In each left horn are three smaller cotyledons, lying towards the mesometrial border and which almost completely fill the cavity of the horn. Typical measurements are $8 \times 7 \times 4$ cm., $7 \times 6 \times 4$ cm., and $6 \times 4 \times 3$ cm.

Cross-section of a cotyledon shows it to be a convex cap of fœtal tissue superimposed on the maternal caruncle. The fœtal villi are straight filiform processes, several of which arise from a broader common stem, and interlock in the spaces made by the network of maternal crypts. Preliminary investigation suggests that the maternal tissues are everywhere covered by a layer of epithelium.

The amnion occupied most of the right horn, with a short projection towards the septum. It was firmly attached for several inches to that part of the chorion on the anti-mesometrial wall of the uterus, but loosely arranged elsewhere. In two specimens the inner aspect of the amnion was speckled with numerous discrete white patches 2–3 mm. in diameter; the third exhibited equally numerous firm, inwardly directed yellow papillæ. Both the white patches and the papillæ were most numerous at the umbilical region. The amniotic fluid was bright yellow in colour.

The umbilical cord is 10–12 cm. in length, and 2¼–3 cm. in diameter. There are two umbilical arteries and two thick-walled umbilical veins which join at the umbilicus. The allantoic stalk is also present. One umbilical artery and vein pass to the two larger cotyledons in the same horn as the fœtus, and the other umbilical artery and vein pass round the edge of the septum and divide to supply the three smaller cotyledons.

The allantoic sac is orientated towards the mesometrial border. It lies partly in the right horn and passes under the septum into the left horn. The septum is covered by the allantois on both surfaces.

The striking features of the placentation in this deer are the large size and the small number of the cotyledons. The number of cotyledons in the placenta of this animal is smaller than in any of the oligocotyledonary species described by Andresen[1]. More detailed histological observations will be published elsewhere in due course.

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[1] Andresen, A., *Morph. Jahrb.*, **57**, 410 (1927).

Variability in Larval Stages of Cirripedes

In the course of an investigation of the biology of fouling organisms, we have studied the planktonic stages of the commoner British balanids, including those of *Balanus perforatus*, *Balanus improvisus* and *Balanus amphitrite*, which have not previously been described.

A general comparison of the six naupliar stages of these species emphasizes the very limited value of setation formulæ as a method of separating species. It appears from our results that the setation, which always increases from one stage to the next, is a developmental rather than a specific feature, and is useful mainly in separating stages within the species. The species are more conveniently differentiated by characters such as shape, size, carapace and labrum development.

Variation among Later Nauplii of *Balanus crenatus*

Stage	Antennule	Mandibular exopodite	Mandibular endopodite	Eye	Sucker	Maxillule	Size and standard deviation	Number of individuals in sample	Total No. of advanced characters
V (early)	1114/2111	0/3	0/343	—	—	—	855 ± 18 μ	0	0
V (late)*	1114/2121	0/3	0/343	—	—	—	897 ± 23 μ	3	1
VI (early)	1114/2121	0/3	0/343	—	+	+	921 ± 25 μ	8	3
(mid)*	1114/2121	0/3	0/343	+	++	+	963 ± 30 μ	2	5
(mid)	1114/2121	0/4	0/343	+	++	+		2	6
(late)	1114/2121	0/3	0/343	++	+++	++	906 ± 10 μ	3	9
(late)	1114/2121	0/4	0/343	++	+++	++		1	10

+, ++, +++, represent degree of development. * Corresponds to Pyefinch's description.

Moreover, while never more than six well-defined naupliar stages have been found in any species, small variations in setation have been noted where the setation of one stage is associated with characters belonging normally to an earlier or later stage. For example, the mandibular exopodites of *Balanus improvisus* and *Balanus amphitrite* var. *denticulata* stage II sometimes resemble stage III in bearing five instead of four setæ. In *Balanus perforatus* the setation of a stage III nauplius is occasionally shown by individuals with size and general characters of a stage II. The existence of such variations is interesting in view of Pyefinch's suggestion that such might be the cause of discrepancies between his and Hertz's description of *Balanus crenatus* larvæ[1,2]. We have checked Pyefinch's description of Millport specimens against larvæ from Brixham and from Burnham-on-Crouch, and find no major difference exists, though our own samples resembled Bassindale's[3] rather than Pyefinch's description of the mandibles of stage II nauplii. However, we have found some interesting developmental intermediates in stages V and VI as set out in the accompanying table. It will be noted from the table that individuals with more fully developed setation are generally more advanced in other respects. No variations of this kind have been observed in the later stages of *Balanus perforatus*, *improvisus* or *amphitrite*, in which species the setation of these stages conforms to a well-defined pattern. However, in *Balanus balanoides* stage VI, some individuals possessed three instead of the two pre-axial antennulary setæ shown by Bassindale. We think it is significant that *balanoides* and *crenatus* are cold-water forms, and, in both, the number of setæ in the later stages is variable and smaller than that present in other *Balanus* species found breeding in warmer waters.

The temperature at which the larva develops appears important with reference to another feature;

amphitrite and *improvisus* show an early development of paired eye rudiments and maxillules, while the increases of absolute size and relative size between stages are generally less in those species that live under warmer conditions. To a lesser degree, differences have been noted within a single species, the larvæ developing under colder conditions reaching a rather larger size. We suggest the following interpretation of these facts. The rate of morphological development of eyes, limbs, setæ, etc., is more strongly influenced by temperature than is the rate of growth and onset of ecdyses. Consequently, the latter do not always occur exactly in step with the former. Cold-water species may show a tendency to pædomorphism, a longer developmental period, and greater growth, while their later stages are particularly susceptible to variation.

Applying this principle to the discrepancies between Pyefinch's and Hertz's accounts, the description given by Hertz might be expected of a warm-water variant of *Balanus crenatus*. The nauplii are smaller, and appear to have a more complete setation. Indeed, but for the existence of carapace spines in stage III (stage IV of Hertz), the size, shape and characters are nearer to those of a normal *improvisus* than a *crenatus*. The species described by Hertz is not identical with our own *crenatus* in several other respects: its summer- and autumn-breeding period, its warm estuarine environment, its rapidly developing larval stages, and the appearance of the spat on fixation also resembling more closely our *Balanus improvisus*.

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[1] Pyefinch, *Proc. Zool. Soc.*, **118**, 916 (1949).
[2] Hertz, *Biol. Bull.*, **64**, 432 (1933).
[3] Bassindale, *Proc. Zool. Soc., Lond.*, 57 (1936).

Chromulina pusilla Butcher, a Dominant Member of the Ultraplankton

Recent researches have stimulated interest in marine nannoplankton. Hydrographical evidence suggested that the bulk of organic production off Plymouth might have been due to autotrophic flagellates rather than to diatoms[1]. The pigment-extraction method indicated that during frequent sampling more than 90 per cent of the total mass of phytoplankton passed through the meshes (40 μ × 50 μ) of a fine net, and that on the only two occasions for which results are given, about 40 per cent passed through Whatman No. 2 filter paper[2]. The small size of ultraplankton organisms (about 5 μ; Thorson[3] gives references to the authors of this unfamiliar but convenient term) does not prevent their use as food by important members of the zooplankton, for a pure culture of a flagellate less than 2 μ in size has supported growth in *Calanus*[4]. Flagellates of about 10 μ or less form the essential food of oyster larvæ[5–7], and hence probably of most of the planktotrophic larvæ which are met with in the development of more than 70 per cent of all benthic invertebrates[8].

Preliminary studies of nannoplankton systematics[9,10] have included the first description of the 1·5-μ chrysomonad *Chromulina pusilla* Butcher. This flagellate is abundant and can only have escaped description earlier because of its minute size. The difficulty of distinguishing between such flagellates and bacteria has been reported previously[11]. In hæmacytometer counts[12] under ⅛-inch objectives, it requires much experience to distinguish between these and specks of detritus. A quantitative culture method provides a possible solution to the problem, and, at the suggestion of Dr. H. A. Cole, tests were carried out with a dilution method, based on that used for estimating numbers of sewage bacteria in contaminated water supplies[13,14]. With bacteriological test tubes and with Erdschreiber[15] as a medium, this has proved suitable for nannoplankton estimation.

Chromulina pusilla appeared in every series of dilutions taken from estuaries, creeks and the open sea, and placed without delay in north-facing windows. Its distribution among the test-tubes indicated densities in sea water varying between 50 and 3,500/ml., with a mean of more than 1,000/ml. (Table 1). Probably some individuals failed to give rise to cultures because of unsatisfactory conditions or competition from other organisms. Its true densities may well have been higher. Although it was not the most numerous species in some samples, no other single species was nearly so widely distributed or generally abundant. No other species of flagellate less than 2 μ in size was observed. Only surface samples were estimated; but there is no reason to doubt that this form will prove to be present throughout the depth of the euphotic zone. In view of the vastness of the sea areas surrounding the British Isles, it may well prove to be the most numerous organism on the British list.

Table 1

Date	Locality	Probable No./ml.	Standard error
Sept. 1946	Conway Estuary at high-water	3,480	1,890
Apr. 1947	" "	50	30
Oct. 1946	Helford River, Cornwall	3,480	1,890
June 1948	R. Crouch, Essex, opposite Burnham	110	60
Dec. 1948	" "	50	30
Jan. 1949	Southern Bight of North Sea	49	28
Dec. 1949	North Sea, opposite Firth of Forth	542	330

As might be expected in so small a flagellate, its "relative speed"[16] is very high. Individuals in culture have been observed to travel fifty times their length per second.

The hardiness of *C. pusilla* in culture and its numerical dominance in the sea suggest that it must have been met with during previous culture work. The organism isolated at Plymouth and termed flagellate *D* by the late Dr. Fabius Gross was probably this species, to judge from brief notes on its size and colour (yellowish-green)[4]. If so, we have information about its value as food for *Calanus* and a single record of its growth-rate in culture[17]. The growth-rate observed was not remarkably rapid, the generation time being, at best, not much less than a day.

Flagellate *F* at Port Erin, which was of similar size and colour, supported growth in oyster larvæ, although the densities at which it was supplied were no greater than those used in other, very successful feeding experiments with much larger (5 μ) organisms.

At Conway, oyster larvæ have been reared on a diet of *Chromulina pusilla*. Larvæ were liberated by oysters isolated in small bowls. Several broods of

larvæ proved to be non-viable. The brood which showed the best growth was one which had been divided among four bell-jars each containing thirty litres of sea water. The water was aerated but not changed during the experiments. Its temperature varied between 15° and 20°. Two of the jars were supplied with a culture of *Chromulina pusilla*, the remaining two with the 5-μ flagellate, *Isochrysis galbana* Parke (Port Erin Flagellate *I*), which has been shown to be an excellent food[7]. The sea water in the jars had not been filtered; but no other flagellates were observed in it after the first few days, and there is no doubt that the growth observed in the numerous, somewhat crowded larvæ was due to the cultures provided. The results indicated that the two organisms are of similar food value (Table 2).

Table 2

Jar No.	Culture used	pH range	Duration of exp. in days	Results
8	*C. pusilla*	8·25–8·40	26	62 settled spat
9	*I. galbana*	8·35–8·40	11	Good growth but no spat
10	*C. pusilla*	8·25–8·40	26	304 settled spat
11	*I. galbana*	8·40–8·70	49	684 settled spat

It would be interesting to have more information about the horizontal and vertical distribution of *Chromulina pusilla*, its fluctuations in abundance, use as food by plankton animals and rate of multiplication and of removal by grazing. Its minute size raises serious difficulties. The most satisfactory way of estimating its abundance would appear to be a quantitative dilution method, using standard culture conditions.

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[1] Atkins, W. R. G., *Nature*, **156**, 446 (1945).
[2] Harvey, H. W., *J. Mar. Biol. Assoc.*, **29**, 97 (1950).
[3] Thorson, G., *Medd. Komm. Danmarks Fisk. Havunde., Ser. Plankton*, **4**, No. 1 (1946).
[4] Raymont, J. E. G., and Gross, F., *Proc. Roy. Soc. Edin.*, B, **61**, 267 (1942).
[5] Cole, H. A., Fish. Invest., Series II, **15**, No. 4 (1936).
[6] Cole, H. A., Fish. Invest., Series II, **16**, No. 4 (1939).
[7] Bruce, J. R., Knight, M., and Parke, M. W., *J. Mar. Biol. Assoc.*, **24**, 337 (1940).
[8] Thorson, B., *Biol. Rev.*, **25**, 1 (1950).
[9] Parke, Mary W., *J. Mar. Biol. Assoc.*, **28**, 255 (1949).
[10] Butcher, R. W., *J. Mar. Biol. Assoc.* (in the press).
[11] Gross, F., Raymont, J. E. G., Nutman, S. R., and Gauld, D. T., *Nature*, **158**, 187 (1946).
[12] Cole, H. A., and Knight-Jones, E. W., *Nature*, **164**, 604 (1949).
[13] Ministry of Health. Rep. Pub. Health and Med. Subjects, 71 (revised edition, 1940).
[14] Swaroop, S., *Ind. J. Med. Res.*, **26**, 353 (1938).
[15] Gross, F., *J. Mar. Biol. Assoc.*, **21**, 753 (1937).
[16] Lowndes, A. G., *Nature*, **155**, 579 and 795 (1945).
[17] Gross, F., and Kocxy, F. F., *Göteborgs Kungl. Vetenskaps- och Vitterhets-samhälles Handl. Sjätte Följden*, Ser. B, **5**, 3 (1946).

Bacterial Isolates from Root Nodules of Zygophyllaceæ

In 1946, Sabet[1] has recorded the occurrence of bacterial root-nodules in the Zygophyllaceæ. His work was mainly concerned with a study of the growth response, as well as stimulation of nodule-formation, of *Zygophyllum coccineum* in either sterilized or unsterilized soil. No work has been done, however, to carry out cross-inoculation experiments with the isolated zygophyllaceous bacterial organisms in relation to either different genera of the same family (that is, Zygophyllaceæ) or to those of Leguminosæ.

Cross-Inoculation Experiments of Leguminous Plants with Bacterial Isolates from some Members of the Zygophyllaceæ

Bacterial isolates from:	Leguminous plants				
	Trifolium alexandrinum	*Phaseolus vulgaris*	*Vicia Faba*	*Lupinus perennis*	*Arachis hypogæa*
Zygophyllum coccineum	±	(−)	(−)	(−)	+
Tribulus alatus	+	(−)	(−)	(−)	+
Fagonia arabica	(−)	±	(−)	(−)	±

+, All plants are nodulated; ±, some plants are nodulated; and (−), all plants are non-nodulated.

The present work is rather preliminary and aims at the elucidation of the two following points:

(1) The possible ability of the bacterial isolates from different genera of Zygophyllaceæ to produce nodules in some members of Leguminosæ.

(2) The growth response and stimulation of nodule-formation in *Zygophyllum coccineum* either to its own specific bacterial isolate or to those of *Tribulus alatus* and *Fagonia arabica*.

Cross-inoculation experiments have been carried out by using suspensions of bacterial cultures grown on yeast-extract mannitol liquid medium. The inoculated plants were observed daily for growth, nodule stimulation and formation.

The capacities of zygophyllaceous bacterial isolates in stimulating nodule-formation in Leguminosæ are shown in the accompanying table.

These leguminous plants, cross-inoculated with zygophyllaceous bacterial isolates, were compared with those inoculated with the specific organism (that is, *Rhizobium species*). In the case of the peanut, *Arachis hypogæa*, where the nodulation is clear and dominant, the cross-inoculated plants showed even more vigorous growth than those inoculated with the specific bacterial organism. They showed large nodules located on the upper part of the root (Fig. 1), while small nodules were found also scattered over the entire root system. The induced type of nodulation differed from the normal type of peanut, and is more closely related to the zygophyllaceous type.

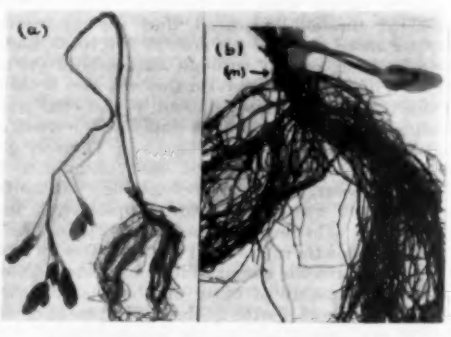

Fig. 1. Peanut, *Arachis hypogæa*, plant cross-inoculated with the bacterial isolate from root-nodule of *Zygophyllum coccineum*: (*a*) entire plant (reduced to ½ natural size), and (*b*) root system to show the nodules (*n*), reduced to 2/5 natural size)

Fig. 2. *Zygophyllum coccineum* plants cross-inoculated with *Tribulus alatus* nodular bacterium ($C \times T$), with that of *Fagonia arabica* ($C \times F$), or with its own nodular bacterium ($C \times C$); the plants are about one year old

The type of growth and stimulation of nodule-formation in *Zygophyllum coccineum*, in response to either its own specific nodular bacterium or to those isolated from *Tribulus alatus* and *Fagonia arabica*, are represented photographically (Fig. 2). The plant did not show a decided benefit except in presence of its own specific bacterium; it grows green and healthy, and it blossoms at a comparatively early stage. On the other hand, the cross-inoculated plants showed weak and stunted growth; this is followed by yellowing and death of some branches, and a complete cessation of flower-formation. Similarly, no nodulation was found to occur except in plants inoculated with the specific nodular bacterium. This may indicate a sort of specificity between *Zygophyllum coccineum* and its nodule-forming bacterium.

Further work concerning the growth responses of other zygophyllaceous and leguminous genera to different root-nodule bacteria, as well as the morphological and physiological characters of various bacterial isolates, is still in progress.

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Nov. 6.

[1] Sabet, Y. S., *Nature*, **157**, 656 (1946).

Experimental Evidence of the Pathogenicity of *Fusarium oxysporum* Schl. f. to the Oil Palm (*Elæis guineensis* J.)

In 1946 and 1948 Wardlaw[1] reported the widespread occurrence of a vascular wilt disease of the oil palm in the Belgian Congo and Nigeria, closely comparable strains of *Fusarium oxysporum* Schl. f. being consistently isolated from the necrosed wood-vessels of palms of all ages, including seedling palms 1–2 years old. The morphology and physiology of the fungus have been investigated by Gogoi[2] and its appearance in the wood-vessels described by Kovachich[3].

Evidence of the pathogenicity of the fungus isolated has been sought in a number of inoculation experiments. These will be described in detail elsewhere; here it will be sufficient to indicate the conditions under which proof of pathogenicity has been obtained. Oil palm seedlings of a Tenera–Dura cross were germinated and transplanted in seed-beds. Vigorous, well-developed seedlings, at the two-leaf stage, were selected for experimental treatment. The root system was washed in water. The method of inoculation consisted in dipping the washed root system in a diluted Richard's solution culture of the fungus. The seedlings were then planted, in groups of four, in zinc cylinders (20 cm. diam. × 18 cm. deep, with a hole in the bottom) containing about five litres of soil previously sterilized by chloropicrine or by treatment with steam. The pots, four inoculated and two controls in each series, were protected under an aluminium-sheet roof, and watered every other day.

About forty days after inoculation some leaf yellowing, desiccation, and browning could be observed in the inoculated seedlings, the controls being dark green and healthy. These symptoms increased so that two months after inoculation many of the inoculated seedlings were seriously affected and some were dead. The control plants still remained healthy. The inoculated plants showed both diseased and healthy roots, and necrotic vascular strands could be traced from the roots into the shoot or 'bulb'. No such discolorations were evident in the 'bulbs' of the control plants. On being cultured, the necrotic 'bulb' tissue yielded only pure cultures of *F. oxysporum*. From diseased roots the pathogen was rarely obtained alone. On no occasion was *Fusarium* isolated from the control seedlings. These findings were confirmed in other experiments.

The results obtained show: (1) that *Fusarium oxysporum* is pathogenic to the oil palm, causing rotting of roots and a necrosis of the wood-vessels in the shoot; (2) that the method of inoculation described above may afford a means of investigating the reaction of seedling palms to this pathogen.

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Jan. 5.

[1] Wardlaw, C. W., *Nature*, **158**, 56, 712 (1946); **162**, 850 (1948).
[2] Gogoi, T., *Trans. Brit. Mycol. Soc.*, **32**, 171 (1949); **33**, 121 (1950).
[3] Kovachich, W. G., *Ann. Bot., N.S.*, **12**, 327 (1948).

Terramycin and *Spironema duttoni* Infections

In the course of experiments with terramycin upon various laboratory infections, we have found that the drug has a powerful effect on *Spironema duttoni* in mice. The animals were inoculated intraperitoneally with a suspension of blood from a heavily infected mouse. Untreated mice usually died in three to six days; occasionally a mouse survived and the infection pursued a relapsing course. Treatment with terramycin was given on the day after infection, either by subcutaneous injection or by stomach tube.

A single subcutaneous dose of 12·5 mgm./kgm. of terramycin caused all the mice to survive; but the parasites reappeared in the peripheral blood six days later. With 25 mgm./kgm. all of the mice were cured, and none relapsed over a period of nine weeks. Suspensions of liver, spleen and brain of these animals

were then injected intraperitoneally into further mice; none of them became infected.

When compared with penicillin, terramycin was found to be more than forty times as potent, weight for weight, because a single subcutaneous dose of 1,000 mgm./kgm. of water-soluble penicillin (calcium salt) did not prevent the relapse of the infection after eleven days.

Single doses of 200 mgm./kgm. of terramycin by mouth prevented the death of mice during the initial parasitæmia, but did not prevent relapse; five daily oral doses of 200 mgm./kgm. were curative, no spironemata appearing in the blood during an observation period of six weeks.

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Dec. 13.

A Rapid Turbidimetric Method for the Assay of Antibiotics

Rapidity in the assay of antibiotics confers advantages in the control of production, in therapy, as Schneierson[1] has pointed out with respect to aureomycin, and in the requirement of but limited aseptic precautions.

The method described here enables assays to be made with an incubation time of 30 min. The use of a culture of test organism (*Streptococcus agalactiæ*) in its logarithmic phase of growth makes this possible. By subculturing twice daily, a rapidly growing strain is maintained; by limiting the incubation period during the night, a vigorous culture is obtained in the morning. (The incubation period may be limited in various ways, such as by the use of a water-bath with a time switch, or by immersing the culture in about two litres of cold water in an insulated flask in an incubator.) From the vigorous culture so obtained, one or two litres of a culture in its logarithmic phase can be prepared in one to two hours. A smaller volume of culture can be maintained in its logarithmic phase by hourly dilution for use at any time during the day. The diluting may be controlled by Spekker readings of turbidity, after a few trials have indicated the turbidity at which the growth-rate begins to diminish; but in practice it soon becomes possible to dilute in a few seconds by eye. In a culture of *Str. agalactiæ* in its logarithmic phase, the turbidity increases two- to three-fold in 30 min. Using a 4-cm. cell and starting with a culture giving a Spekker reading on the logarithmic scale of about 0·2 for the difference between culture and clear broth, it is easy to measure the increase due to half an hour's growth with sufficient accuracy.

Serial dilutions of the antibiotic are prepared in sterile broth by adding, with a Record syringe, x ml. of broth to y ml. of antibiotic solution, withdrawing x ml. of this first dilution into a boiling-tube with the same syringe, adding x ml. of fresh broth to the remaining y ml. of first dilution with the same syringe, and repeating the operation until enough dilutions have been made. Normally, $x = y = 5$ for unknown solutions, and $2x = y = 10$ for standard solutions. By using stops on the stem of the plunger, it is possible to retain solution y in the barrel of the syringe, the limited movement of the plunger adding, with adequate mixing, and then subtracting, the volume x ml. With this technique and a spring-activated plunger, it is possible to prepare sets of serial dilutions with seven dilutions in each set at the rate of one set per minute.

A hand-operated ampoule-filling machine (A. J. Manning, Wembley) is used for adding rapidly and with sufficient mixing 15 ml. of logarithmic culture of test organism to each dilution of antibiotic. After thirty minutes incubation, 1 ml. of 0·02 per cent 'merthiolate' solution (E. Lilly, Basingstoke) is added as violently as possible to each tube, again using a spring-operated syringe. Readings of turbidities on the Spekker followed by the usual graphical comparison between standard and unknown solutions enable the concentration of the latter to be calculated.

Standard Deviations of Rapid Assay under Various Conditions

Antibiotic	No. of different samples	No. of replicates from each sample	Range of variates	Standard deviation as percentage of general mean	Notes
'Nisin'	25	2	2·9–7·2	9·0	Duplicates assayed on different days
'Nisin'	12	2	1·8–7·7	5·9	
'Nisin'	9	2	4·1–7·8	3·6	Allowance made for differences in 'slope' and for time between duplicates
Penicillin	1	10	—	2·2	One hour's incubation

The method has proved satisfactory during eighteen months use in assaying all kinds of 'nisin' preparations. Preliminary experiments indicate that it might well be successful also with penicillin, streptomycin, aureomycin and gramicidin. It has not been tried with other antibiotics. The accompanying table shows the standard deviations which have been obtained under various conditions.

We wish to thank Miss S. A. Lamb for technical assistance. It is intended to publish a fuller description of the method elsewhere.

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[1] Schneierson, S. S., *Proc. Soc. Exp. Biol. Med.*, **74**, 106 (1950).

Lipoid Bodies, Golgi Apparatus and Zymogen Formation

The lipoid globules (lipochondria) of the Golgi zone of the mouse pancreas have been identified as the Golgi bodies of the live cells by Hirsch[1], Ries[2], and Worley[3]. They were, however, studied with the aid of vital dyes or after fixation, and the view that they are vesiculated in life has been open to doubt (cf. Palade and Claude[4]).

Observations on mouse pancreases, depleted of mature zymogen by injections of pilocarpine, have been made on both fresh slices of tissue in 0·85 per cent sodium chloride, and in the pancreas with intact circulation after the method of Hirsch[5]. It has been found that whereas some of the lipochondria are, in fact, homogeneous and not vesiculated, the majority are vesiculated in life. They appear as circles or crescents in cross-section. Though in both the full

and emptied pancreas the majority of these lipochondria are single structures, in the emptied pancreas a much greater number are found which are compound bodies composed of a number of vesicles. The size of the lipochondria ranges from $\frac{1}{2}\mu$ to 3μ, the majority being $1\frac{1}{2}\mu$ in diameter. In the liver the lipoid droplets are not vesiculated in life.

Both the liver lipoid droplets and the lipochondria of the pancreas are selectively stained *in vivo* by methylene blue, toluidene blue, neutral red, brilliant cresyl blue and nile blue sulphate. In hypertonic solutions of sodium chloride, the methylene blue and toluidene blue stained bodies of both organs undergo changes of form (myelination) similar to those which phospholipide droplets undergo in forming myelin figures. The stained lipochondria also become myelinated vigorously in sodium chloride solutions as low as 1·4 per cent, which is far below the concentration isotonic for the pancreas[6]. Myelination of the methylene blue stained bodies has also been obtained in solutions of sodium bicarbonate, calcium chloride and slightly in sucrose solutions. The myelin figures so formed closely simulate the classical Golgi net. Palade and Claude[4] showed that the lipoid droplets of the liver became myelinated in classical Golgi fixatives and could be stabilized and impregnated with osmic acid to give the classical Golgi apparatus of the liver. Their observation that they also become myelinated after treatment with alcoholic solutions of sudan black to simulate the classical Golgi apparatus has been confirmed.

The neutral red stained droplets of both liver and pancreas do not show myelin figure formation in hypertonic solutions of sodium chloride.

In distilled water, irrespective of the presence or absence of dye in the water, the methylene blue, toluidene blue, and neutral red stained lipoid bodies of both liver and pancreas readily destain and form artefact structures, the 'vacuome–crinome' complexes. These are composed of a clear non-refractile vacuole, within and at one pole of which there is segregated a small amount of refractile yellowish material. No such artefacts form in undamaged material in 0·85 per cent sodium chloride.

There seems to be no doubt that the lipoid bodies of the liver are the Golgi bodies of the live cells, and from the data above there is seen a remarkable parallel between the properties of the vitally stained lipoid droplets of the pancreas and liver, both in the selectiveness of staining, in the simulation of the classical Golgi nets on advanced myelination, and in the formation of vacuome–crinome complexes. These data further confirm the view of Hirsch[1], Palade and Claude[4], and Baker[7] that the Golgi bodies of the living pancreas are, in fact, the lipochondria. It is established, however, contrary to the opinion of Palade and Claude, that the lipochondria of the pancreas are vesiculated in life. Also, it is established that the methylene blue stained droplets of the liver are not neo-formations or bodies other than the lipoid droplets, but that, in fact, they are the lipoid droplets.

In discussing the relation of the lipochondria or Golgi bodies of the pancreas to the formation of zymogen granules, the nomenclature of Hirsch[1] will be followed in describing the walls of these bodies as the Golgi externa, and the vesicles enclosed by them as the Golgi interna. Hirsch[1,5] and Ries[2] both depict, as the earliest prozymogen granules free of encirclement by Golgi externa, bodies which are approximately the size of mature zymogen granules (that is, $1\frac{1}{2}\mu$). A study of the empty and restituting mouse pancreases obtained by feeding or pilocarpine injections shows that this is incorrect. The earliest prozymogen visible in live tissue is less than $\frac{1}{2}\mu$ in diameter and is, in fact, almost at the limits of microscopic visibility. These prozymogen granules are well spaced from each other, and, when the objective is focused slightly beyond them, they are readily visible as dull-darkish bodies surrounded by clear 'vacuoles' at the centres of which they are situated. However, on bringing them into proper focus, they are seen as glistening yellowish granules which are, in fact, not surrounded by vacuoles. This young prozymogen does not stain with the vital dyes listed above, nor are the individual granules surrounded even partially by chromophilic or osmiophilic material. The chromophile and osmiophile lipochondria or Golgi bodies are found at the base of the prozymogen mass. The interna of these are larger than the young prozymogen. No evidence was found for the view that the prozymogen formed within the Golgi interna, and it was definitely disproved that they matured within the interna. Nor was there any evidence that the smaller non-vesiculated Golgi bodies were a stage in a possible transformation to prozymogen granules, since they stained more readily with vital dyes than did the larger lipochondria, and were quite as osmiophilic as them. It has been concluded that the vesiculated lipochondria are not organelles of zymogen synthesis, but are very elementary myelin forms, and that their further myelination after vital staining is due to alterations in their surface properties.

This work was carried out in the Zoological Department, University of Melbourne.

N. Xeros

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Feb. 5.

[1] Hirsch, H. C., "Form- und Stoffwechsel der Golgi-Korper" (Berlin: Borntraeger, 1939).
[2] Ries, E., *Z. Zellforsch.*, **22**, 523 (1935).
[3] Worley, L. G., *J. Morph.*, **75**, 261 (1944).
[4] Palade, G. E., and Claude, A., *J. Morph.*, **85**, 35 and 71 (1949).
[5] Hirsch, H. C., *Z. Zellforsch.*, **15**, 36 (1932).
[6] Opie, E. L., *J. Exp. Med.*, **89**, 185 (1949).
[7] Baker, J. R., *Quart. J. Micr. Sci.*, **90**, 293 (1949).

Record of a Whale Shark off the West Coast of Malaya

In going through some records which have survived the Japanese occupation, a photograph and account of the catching of a specimen of the rare whale shark, *Rhineodon typicus*, have come to light.

The fish was caught on November 25, 1940, off a sandy beach on the coast of Pangkor Island off the west coast of the Malay peninsula. Unfortunately there is no record of the sex. The fish was thirty-five feet long and twenty-three feet between the outstretched pectoral fins. It was caught in a beach seine about one mile in length, operated by Madras fishermen who migrate to Malaya. The fish was cut up and thrown back into the sea. The fishermen weighed just over thirteen thousand three hundred pounds of flesh and then tired.

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(Director)

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Nov. 6.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, March 19

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. A. C. B. Lovell: "Radio Astronomy".

INSTITUTE OF PHYSICS, INDUSTRIAL SPECTROSCOPY GROUP (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Dr. H. Kaiser: "Investigations on the Spectral Character of Spark Sources" and "Outline of a Theory of Spectrochemical Evaluation".

INSTITUTION OF THE RUBBER INDUSTRY, MANCHESTER SECTION (at the Engineers' Club, Albert Square, Manchester), at 6.15 p.m.—Dr. D. S. Gordon Darnton: "A Method of Estimating Brownian Activity in Latex and Latex Dispersions".

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Mr. H. W. Tilman: "Explorations in the Nepal Himalaya".

Monday, March 19—Wednesday, March 21

OIL AND COLOUR CHEMISTS' ASSOCIATION, LONDON SECTION (at the Borough Polytechnic, Borough Road, London, S.E.1), at 2.30–8.30 each day.—Technical Trade Exhibition of Raw Materials and Equipment used in the Paint, Varnish and Printing-Ink Industries.

Tuesday, March 20

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (in the Chemistry Lecture Theatre, Royal College of Science, South Kensington, London, S.W.7), at 2.30 p.m.—Dr. F. N. Woodward: "Agricultural By-Products and their Industrial Utilization".*

ROYAL ANTHROPOLOGICAL INSTITUTE (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Mr. P. G. H. Strehlow: "Central Australian Sacred Totemic Ceremonies" (Colour Films).

MANCHESTER GEOGRAPHICAL SOCIETY (at the Geographical Hall, 16 St. Mary's Parsonage, Manchester), at 6.30 p.m.—Dr. G. D. Nicholls: "Arctic Volcanoes—The Island of Jan Mayen".

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMER GROUP (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Dr. P. A. Small: "Some Factors affecting the Solubility of Polymers".

INSTITUTION OF WORKS MANAGERS, LEICESTER BRANCH (at the British Thomson-Houston Co., Ltd., Rugby), at 7 p.m.—Prof. T. U. Mathew: "Management Research with particular reference to Work Study and Job Evaluation".

INSTITUTION OF WORKS MANAGERS, PRESTON GROUP (at the Building Trades Employers Association, Starkie House, Starkie Street, Preston), at 7 p.m.—Mr. A. P. Young: "Industrial Management and its Human and Social Implications".

TEXTILE INSTITUTE, MACCLESFIELD, LEEK AND DISTRICT SECTION (at the Memorial Hall, Macclesfield), at 7.45 p.m.—Mr. F. C. Harwood: "Laundering and the Manufacturer".

Tuesday, March 20—Wednesday, March 21

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1).—Anniversary Meetings.

Tuesday, March 20

At 4 p.m.—Prof. E. K. Rideal, F.R.S.: "Concepts in Catalysis—the Contributions of Paul Sabatier and Max Bodenstein" (Presidential Address).

Wednesday, March 21

At 11.30 a.m.—One Hundred and Tenth Annual General Meeting.

Wednesday, March 21

INSTITUTE OF FUEL (at the Technical College, Lincoln), at 10 a.m. and 2.30 p.m.—Papers on "Drying in Agriculture".*

PHYSICAL SOCIETY, COLOUR GROUP (at the Royal Photographic Society, 16 Prince's Gate, London, S.W.7), at 3.15 p.m.—Annual General Meeting; at 3.30 p.m.—Dr. W. S. Stiles: "The Bearing on Colour Theory of some Recent Studies of Visual Sensitivity".

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Prof. E. Palmén: "The Role of Atmospheric Disturbances in the General Atmospheric Circulation" (Symons Memorial Lecture).

ROYAL STATISTICAL SOCIETY, RESEARCH SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. D. G. Kendall: "Some Problems in the Theory of Queues".

INSTITUTION OF ELECTRICAL ENGINEERS, SUPPLY SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. R. L. Chantrill: "Variable-Voltage Generation applied to A.C. Power Systems".

ROYAL STATISTICAL SOCIETY, BIRMINGHAM GROUP OF THE INDUSTRIAL APPLICATIONS SECTION (at the Chamber of Commerce, 95 New Street, Birmingham), at 6.30 p.m.—Mr. S. Brand: "The Use of Punched Card Equipment for Statistical Analysis".

INSTITUTE OF PETROLEUM, STANLOW BRANCH (at the Grosvenor Hotel, Chester), at 7.15 p.m.—Prof. F. Morton: "Origin and Migration of Petroleum".*

Thursday, March 22

INSTITUTE OF METALS, BIRMINGHAM SECTION (at the James Watt Memorial Institute, Great Charles Street, Birmingham), at 6.30 p.m.—Mr. C. J. Moss: "Adhesives for Metals".

BRITISH INSTITUTION OF RADIO ENGINEERS, SCOTTISH SECTION (at the Institution of Engineers and Shipbuilders, 39 Elmbank Crescent, Glasgow), at 7 p.m.—Mr. H. W. Gale: "Magnetic Amplifiers".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ENGINEERS and PHYSICISTS (Principal Scientific Officer grade) at a Ministry of Supply design establishment near London: (Ref. C.134/51A) with a first- or second-class honours degree, or equivalent, in engineering or physics, to take charge of a section dealing with development of new projectiles; (Ref. C.135/51A) with a first- or second-class honours degree in mechanical engineering, with good mathematical ability, to take charge of a section dealing with the stressing of complex structures—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (March 24).

HEAD OF THE ENGINEERING DEPARTMENT of the projected Gold Coast College of Arts, Science and Technology—The Secretary, Advisory Committee on Colonial Colleges of Arts, Science and Technology, 15 Victoria Street, London, S.W.1 (March 24).

LECTURER IN MATHEMATICS—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (March 24).

BIOCHEMIST in the Department of Soil Microbiology, to undertake research in legume symbiosis—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (March 25).

LECTURER IN THE DEPARTMENT OF ELECTRICAL ENGINEERING—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (March 28).

ASSISTANT LECTURERS IN ZOOLOGY, CHEMISTRY AND PHYSICS, at Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (March 31).

ASSISTANT PHYSICIST in the Physics Department of the Sheffield National Centre for Radiotherapy—The Secretary, Sheffield Regional Hospital Board, Broom Cross, Tree Root Walk, Sheffield 10 (March 31).

BIOCHEMISTS or CHEMISTS (with good honours degree or its equivalent) interested in biological problems, a SENIOR SCIENTIFIC OFFICER for research on problems of milk composition, and a SCIENTIFIC OFFICER to assist with osmotic studies of milk and blood and with enzyme and protein work—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, Berks (March 31).

LECTURER (with a first- or second-class honours degree in mechanical engineering) IN THE DEPARTMENT OF APPLIED MECHANICS—The Director of Studies, Royal Naval College, Greenwich, London, S.E.10 (March 31).

LECTURER IN STATISTICS in the Department of Mathematics—The Registrar, King's College, Newcastle-upon-Tyne (March 31).

LECTURER or a SENIOR LECTURER IN AGRICULTURAL ZOOLOGY—The Registrar, The University, Leeds 2 (March 31).

AREA SCIENTIST (with a good honours degree and sound experience in fuel technology and coal analysis) in Cannock and Tamworth—The Divisional Establishment Officer, National Coal Board, West Midlands Division, Himley Hall, Dudley, Worcs.

ASSISTANT EXPERIMENTAL OFFICERS (2) IN THE CHEMISTRY DEPARTMENT, mainly for work on the composition of milk and feeding-stuffs—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, Berks.

BIOCHEMIST or CHEMIST for research on fundamental problems related to the nervous system, and a RESEARCH ASSISTANT (preferably graduate, with experience in physiology or histology) to assist in physiological research—The Secretary, Whitchurch Hospital, Cardiff.

CHIEF MECHANICAL AND ELECTRICAL ENGINEER by the Directorate General of Municipalities, Iraq—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.24754B.

CIVIL ENGINEER IN THE PUBLIC WORKS DEPARTMENT, Nigeria, for work on water supplies—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27322/76.

EXECUTIVE ENGINEER IN THE PUBLIC WORKS DEPARTMENT, Tanganyika—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27322/1.

IRRIGATION ENGINEER IN THE AGRICULTURAL DEPARTMENT, Nyasaland—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27322/81.

LECTURER (with industrial and/or teaching experience) to specialize in Fuel Chemistry and Technology—The Secretary, Royal Technical College, Glasgow.

LECTURER (with a university degree in science) IN THE DEPARTMENT OF CHEMISTRY—The Principal, Borough Polytechnic, Borough Road, London, S.E.1.

LECTURER (university graduate with an honours degree in engineering or physics) IN REFRIGERATION, and a LECTURER (with a degree in mechanical engineering and some practical experience of fan application) IN FAN ENGINEERING—The Clerk to the Governors, National College for Heating, Ventilation, Refrigeration and Fan Engineering, Borough Polytechnic, Borough Road, London, S.E.1.

MECHANICAL ENGINEER or PHYSICIST (honours degree in physics or mechanical engineering essential) for practical and theoretical research on forging—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting 'Forging'.

MECHANICAL ENGINEERS (4) in the Public Works Department, Kenya—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27325/10.

METALLURGIST (graduate) for research on physical metallurgy of tin-containing alloys—The Director, Tin Research Institute, Fraser Road, Perivale, Greenford, Middx.

POSTGRADUATE SCHOLARSHIPS IN TEXTILE TECHNOLOGY, TEXTILE ENGINEERING, TEXTILE CHEMISTRY OR DYEING—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

RESEARCH CHEMIST (with university degree, or equivalent)—The Director, British Paper and Board Industry Research Association, Welcomes Road, Kenley, Surrey.

WATER ENGINEER, Antigua, Leeward Islands—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27329/26.

UNIVERSITY OF CAMBRIDGE
SHELL RESEARCH STUDENTSHIP IN CHEMICAL ENGINEERING

The managers of the Shell Chemical Engineering Studies Fund invite applications for a Shell Research Studentship. Applicants should in general have already received a first research degree or at least have shown considerable promise in research. The successful candidate will be required to engage in research in chemical engineering under such conditions as the managers may determine. The Studentship will be of £600 a year, plus fees for two years, with the possibility of an extension for a further year. The successful applicant would be expected to commence residence in October, 1951.

Application forms may be obtained from the Shell Professor of Chemical Engineering, Department of Chemical Engineering, Tennis Court Road, Cambridge, and should be completed and returned by April 25, 1951.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY
ENGLISH ELECTRIC COMPANY'S BURSARIES IN HYDRO-POWER ENGINEERING

Notice is hereby given that a number of English Electric Company Bursars in Hydro-Power Engineering will be elected in June, 1951. The Bursaries are of the value of £200, for one year, tenable for postgraduate study in the Civil Engineering Department of the Imperial College. Bursars pay the appropriate college tuition fee (at present £30). The Bursaries will be recommended for supplementation by the Ministry of Education. Bursars who successfully complete the course will be eligible for the award of the Diploma of the Imperial College (D.I.C.).

Candidates should have an honours degree in engineering, or an equivalent qualification, and applications should be received before June 1, 1951, by the Deputy Registrar, City and Guilds College, Exhibition Road, London, S.W.7, from whom further details may be obtained.

UNIVERSITY OF BRISTOL
BOOTS RESEARCH SCHOLARSHIP

The University invites applications for a Boots Research Scholarship, of the value of £300 per annum, tenable for two years from October 1, 1951, at the Long Ashton Agricultural and Horticultural Research Station. The Scholarship is open to graduates of universities in the British Commonwealth, and the scholar will be required to engage in full-time research in a branch of science pursued at the research station.

Applications, giving full details of qualifications and proposed field of research, should be received by the undersigned not later than May 31, 1951.

H. C. BUTTERFIELD,
Registrar.

UNIVERSITY OF CAMBRIDGE
SHELL CHEMICAL ENGINEERING STUDIES FUND

The managers of the Shell Chemical Engineering Studies Fund invite applications for grants to students who have obtained a good honours degree in chemistry or engineering, and who wish to read for the Chemical Engineering Tripos of the University of Cambridge. The course for the Chemical Engineering Tripos is of two years' duration and is designed for students who have previously taken a degree course in chemistry or engineering. The grants, which will be of £320 a year for two years, will be conditional on the candidate becoming a member of a College in the University, or of Fitzwilliam House, and being granted the privileges of affiliation by the Council of the Senate, and being given leave by the Chemical Engineering Syndicate to proceed to the Chemical Engineering Tripos. Successful applicants will be expected to commence their studies in October, 1951, but the managers will be prepared to consider in special circumstances postponement of such commencement until October, 1952.

Application forms may be obtained from the Shell Professor of Chemical Engineering, Department of Chemical Engineering, Tennis Court Road, Cambridge, and should be completed and returned by May 21, 1951.

RAMSAY MEMORIAL FELLOWSHIPS FOR CHEMICAL RESEARCH

The Trustees will consider in June, applications for Ramsay Memorial Fellowships for Chemical Research. One of the Fellowships will be limited to candidates educated in Glasgow, who can apply to be considered for either Fellowship. The value of each Fellowship will be £400 per annum, to which may be added a grant for expenses of research not exceeding £100 per annum. The Fellowships will normally be tenable for two years.

Full particulars can be obtained from the Joint Honorary Secretaries, Ramsay Memorial Fellowships Trust, University College, London, Gower Street, W.C.1, to whom applications must be forwarded not later than April 17, 1951.

CAMBRIDGE UNIVERSITY
TRAINING GRANTS IN AGRICULTURAL ENGINEERING

Two grants of £300 a year (with family allowances in case of need) open to graduates in agriculture, engineering or the natural sciences, to train for teaching and/or research in agricultural engineering. Grants for one year, renewable for a further year on satisfactory progress.

Applications, in writing, with names and addresses of three referees, to the Secretary, School of Agriculture, Cambridge, by March 31, 1951.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY
LONDON, S.W.7
ROYAL DUTCH SHELL STUDENTSHIP IN GEOPHYSICS

Applications are invited for this studentship, tenable from October, 1951, for a course in geophysical prospecting as applied to the search for oil. Candidates should possess an honours degree either in geology, provided mathematics and physics were taken at the intermediate, or in physics, and the award will be made subject to the passing of a medical examination as to physical fitness to work abroad. The value of the studentship is £330 per annum, from which fees of £30 per annum must be paid, and is tenable for two years, subject to a satisfactory report at the end of the first year.

Applications must be sent to the Registrar, Imperial College, Prince Consort Road, S.W.7, before June 2, 1951.

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